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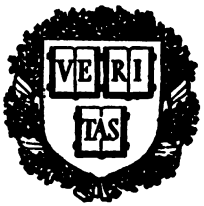

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DEPARTMENT OF THE INTERIOR
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UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

MINERAL RESOURCES

OF THE

UNITED STATES

1915

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MINERAL RESOURCES OF THE UNITED STATES, 1915—PART II.

FUEL BRIQUETTING.

By C. E. Lesher.

PRODUCTION.

Little change was recorded in the fuel-briquetting industry in 1915. The manufacture of this type of fuel is still in its infancy in the United States and probably many years will elapse before it assumes large proportions. The production in 1915 amounted to about 222,000 short tons, valued at about a million dollars, and although there was a decrease, as compared with 1914, of 11 per cent in quantity and 10 per cent in value, the output exceeded that of all years prior to 1914.

The process of briquetting low-grade material and thus converting it into fuel suitable for higher uses is practical conservation, and as such it deserves far more attention than it now receives in this country. European countries, more thrifty in their use of coal, have developed the industry to large proportions, but in the United States only a beginning has been made. By many experiments, some of them costly, most of the mechanical difficulties have been solved, foreign machinery has been adapted to our coals, new machines have been devised, binders have been found, and the best size and shape of the product have been determined. The future growth of this industry in the United States depends on the development of markets for the product, and it is here that the greatest obstacles are met. The producing plants are so widely distributed over the country and the total output is so small compared with that of other kinds of fuel that the conditions affecting the market of each plant are more or less local and peculiar to its own area. In general, in the Eastern States briquets compete with anthracite as domestic fuel, and nearly all the output of the eastern plants is manufactured from anthracite culm or the fine sizes, such as buckwheat. It appears that people in the eastern cities, accustomed to the incomparable anthracite, have not taken very kindly to these briquets, probably because of the volume of tarry smoke those made with coal tar as a binder give off when first ignited and perhaps also because it has not been possible to offer them cheap enough, as compared with the domestic sizes of anthracite,

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to induce their extensive use. Being made from cheap anthracite, the briquets contain more ash than the domestic sizes, which ash reduces the heat value of the fuel, even though it does not clinker in the furnace.

The production of briquetted fuel in the United States in 1915, as shown in the following tables, amounted to 221,537 short tons, valued at $1,035,716, compared with 250,635 tons, valued at $1,154,678, in 1914, a decrease of 29,098 tons, or 11 per cent, in quantity and of $118,962, or 10 per cent, in value.

Fuel briquets produced in the United States in 1914 and 1915.

	1914			1915		
	Number of operating plants.	Quantity (short tons).	Value.	Number of operating plants.	Quantity (short tons).	Value.
Eastern States:						
Maryland	1	.....	.....	1	.....	.....
New Jersey [a]	1	.....	.....	.....	.....	.....
New York [a]	1	.....	.....	.....	.....	.....
Pennsylvania	3	.....	.....	3	.....	.....
Virginia	1	.....	.....	1	.....	.....
	7	101,782	$273,046	5	33,541	$95,174
Central States:						
Michigan	1	.....	.....	1	.....	.....
Missouri	2	.....	.....	2	.....	.....
North Dakota	1	.....	.....	1	.....	.....
Wisconsin	2	.....	.....	2	.....	.....
	6	94,325	456,069	6	99,394	423,178
Pacific Coast States:						
California	1	.....	.....	2	.....	.....
Oregon	1	.....	.....	1	.....	.....
Washington	1	.....	.....	1	.....	.....
	3	54,528	425,563	4	88,602	517,364
	16	250,635	1,154,678	15	221,537	1,035,716

[a] No production reported in 1915.

Briquets produced in the United States in 1907–1909 and 1911–1915, in short tons.

Year.	Quantity.	Value.
1907	66,524	$258,426
1908	90,358	323,057
1909	139,661	452,697
1911	218,443	808,721
1912	220,064	952,261
1913	181,359	1,007,327
1914	250,635	1,154,678
1915	221,537	1,035,716

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RAW MATERIAL AND BINDERS.

Of the briquetting plants in operation in 1915, 4 used anthracite as a raw material; 6, Arkansas semianthracite, West Virginia semibituminous or bituminous slack, or mixtures of them; 1, a mixture of anthracite culm and bituminous slack; 1, lignite; 1, a mixture of lignite, anthracite culm, and bituminous slack; and 2, oil-gas residue. Five plants used coal-tar pitch as a binder; 2, tar mixed with other substances; 3, asphaltic pitch; 1, an organic binder; and 1, petrolastic cement. No binder is required in briquetting carbon residues from oil-gas works, or at the lignite plant in California.

Raw fuels used in making briquets in 1914 and 1915, in short tons.

	1914	1915
Anthracite culm and fine sizes	112,236	53,118
Semianthracite	85,054	123,944
Semibituminous		
Bituminous slack		
Lignite	40,928	37,742
Oil-gas residue		
	238,218	214,804

PROGRESS OF THE INDUSTRY.

The number of plants manufacturing briquets in the Eastern States, as shown in figure 1, increased steadily from 1907 to 1911, but has decreased each year since that time. Likewise the production, shown in figure 2, which in the period from 1907 to 1911 nearly trebled, in 1915 (output 33,541 tons) had decreased to 20,000 tons less than in 1907 and to 126,000 tons less than in 1911.

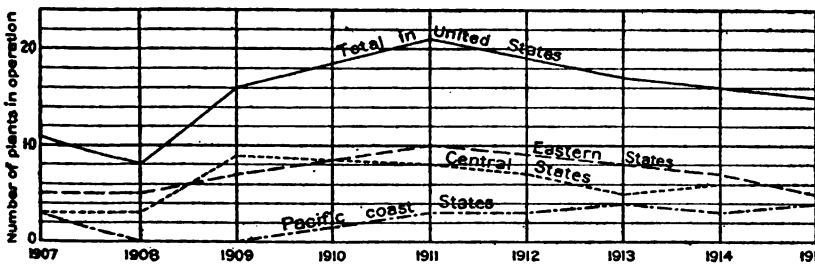

FIGURE 1.—Number of plants manufacturing briquets, 1907 to 1915, in the Eastern, Central, and Pacific Coast States, and in the United States.

In the Central States, where competition with anthracite is not so sharp, the production has increased every year since 1907, except 1913. As shown graphically in figure 2, progress was gradual from 1907 to 1911, but in 1912 there was a large increase, and in 1914 and in 1915 the output was greater than in 1912. During the earlier period, particularly in 1909 and 1911, a number of the plants whose output is recorded were only in the experimental stage and their small production brought down the general average. Nearly all the briquets in the Central States are manufactured from bituminous,

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semibituminous, or semianthracite, or mixtures of these kinds of coal. The plant of the Northern Briquetting Co., at Minot, N. Dak., uses the residue from brown lignite, which, after dry distillation in ovens of the type employed in making beehive coke, is mixed with a

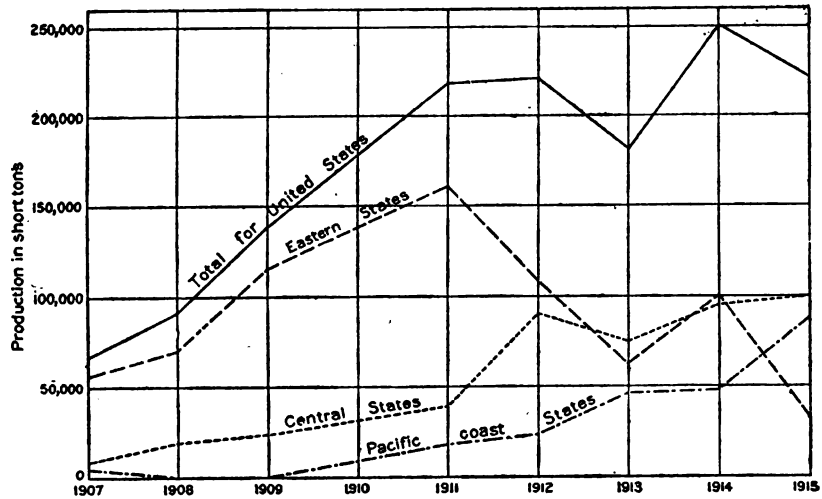

FIGURE 2.—Production of fuel briquets, 1907 to 1915, in the Eastern, Central, and Pacific Coast States, and in the United States.

small quantity of bituminous slack, anthracite culm, and a binder composed of tar and low-grade flour. The plants in Wisconsin use bituminous slack and anthracite fines obtained from the rescreening plants of the coal-storage docks at the head of the Lakes.

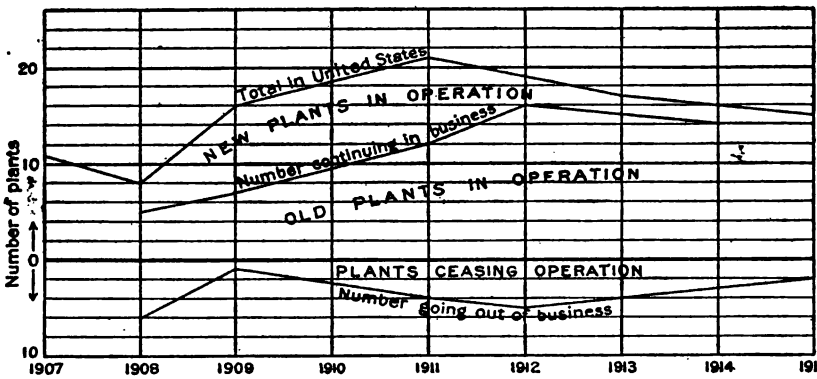

FIGURE 3.—Comparison by years, from 1907 to 1915, of the number of old and new operating fuel-briquetting plants to total in the United States and to the number ceasing operation.

On the Pacific coast the progress of the fuel-briquetting industry has been steady during the last five years. There was no output in 1908 and 1909, but in 1911 the production (from 3 plants) was nearly 20,000 tons. In 1915 four plants manufactured 88,000 tons of briquets, more than twice the output of the five plants in the

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Eastern States and within 11,000 tons of the output at the six establishments in the central region. In fact, owing to the increased activities of the Pacific Coast Coal Co., in Washington, and the addition of one new plant, in California, the product increased nearly two-thirds in 1915 as compared with 1914.

As illustrating the history of the development of the briquetting industry in the United States figures 3 and 4 are interesting. The upper curve in figure 3 shows by years the number of operating plants, the total for each year comprising the plants in operation during the preceding year plus new plants. It will be noted that the number was greatest in 1911, and it has shown a gradual decrease since then. The number of plants that continued in operation from the preceding year is shown by the next lower line on the diagram. The number that continued active from one year to the

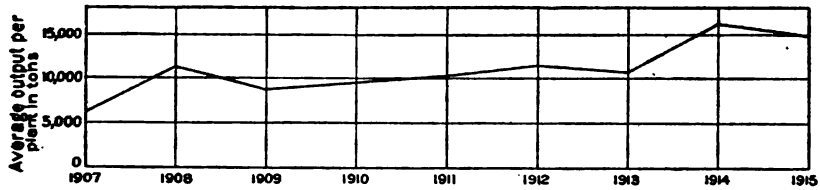

FIGURE 4.—Average annual output per plant of the fuel-briquetting plants in the United States, 1907 to 1915, in short tons.

next is seen to have increased from 5 in 1908 to 16 in 1912 and to have remained practically the same since then. The interval between this curve and the uppermost curve represents the number of plants going into operation each year. The period between 1908 and 1912 was characterized by the comparatively large number of new installations and may be considered to represent the experimental stage of development. The indications are that this stage has been passed and that future extensions of the industry will be slow but probably more permanent than in the past. The curve below the zero line shows the number of plants going out of business.

Although the total number of operations has decreased annually since 1911, the average output per plant has, on the whole, increased, and in 1915 it was nearly 50 per cent greater than in 1911. The average annual production per plant is shown graphically in figure 4.

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Briquetting plants in the United States in 1915.

Group.	Name of operator.	Address.	Location of plant.	Date put in operation.	Raw fuel used.
Eastern States.					
Maryland	American Coal Boulet Co.	515 Widener Building, Philadelphia, Pa.	Phoenix	1911	Bituminous slack.
Do	[a] Belgium Coal-Fuel Co.	509 Widener Building, Philadelphia, Pa.	do	1915	Do.
Pennsylvania	American Coalette Co.	3242 North Twenty-first Street, Philadelphia, Pa.	Philadelphia	1913	Anthracite.
Do	Lehigh Coal & Navigation Co.	437 Chestnut Street, Philadelphia, Pa.	Lansford	[b]1909	Do.
Do	Scranton Anthracite Briquette Co.	Dickson City, Pa.	Dickson City	1907	Do.
Virginia	Delparen Anthracite Briquet Co.	Parrott, Va.	Parrott	1915	Do.
Central States.					
Michigan	Coalette Fuel Co.	Seventeenth and Hancock Streets, Detroit, Mich.	Detroit	1909	Bituminous slack.
Missouri	Briquette Fuel Manufacturing Co.	1421 Talmage Street, St. Louis, Mo.	St. Louis	1911	Arkansas semianthracite.
Do	Standard Briquette Fuel Co.	319 North Fourth Street, St. Louis, Mo.	Kansas City	1909	Do.
North Dakota	Northern Briquetting Co.	Blaisdell Bird Block, Minot, N. Dak.	Minot	1914	Lignite, anthracite culm, and bituminous slack.
Wisconsin	Berwind Fuel Co.	122 South Michigan Avenue, Chicago, Ill.	Superior	1912	Semibituminous slack.
Do	Stott Briquet Co.	1203 Merchants Bank Building, St. Paul, Minn.	do	1909	Anthracite culm and bituminous slack.
Pacific Coast States.					
California	Lignite Fuel Co.	403 Call Building, San Francisco, Cal.	May	1915	Lignite.
Do	Los Angeles Gas & Electric Corporation.	645 South Hill Street, Los Angeles, Cal.	Los Angeles	1905	Carbon (petroleum residue).
Oregon	Portland Gas & Coke Co.	294 Yamhill Street, Portland, Oreg.	Linnton	1913	Do.
Washington	Pacific Coast Coal Co.	563 Railroad Avenue, South Seattle, Wash.	Briquetteville.	1914	Bituminous slack.

[a] Leased plant of American Coal Boulet Co. in September, 1915.
[b] Plant destroyed by fire in 1909; reconstructed in 1911.

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SAND-LIME BRICK.

By JEFFERSON MIDDLETON.

The sand-lime brick industry made progress in 1915, both the quantity and the value of material sold showing increase compared with 1914. During the later months there was considerable activity and the year closed with bright prospects for 1916.

The increase in the quantity of sand-lime brick sold in 1915 over 1914 was 7,014,000 brick, or 4 per cent, and the increase in value was $76,592, or 7 per cent. The number of active operators reporting was the smallest since the first year for which statistics were collected, but the average value of sales per active operator reporting increased from $17,073 in 1914 to $20,270 in 1915.

Two States (Colorado and Oklahoma) that reported sales for 1914 reported none for 1915 and one State (Connecticut) that reported nothing for 1914 reported sales for 1915. Eleven of the 21 States reporting sales of sand-lime brick in both 1914 and 1915 showed increase in value and 10 showed decrease in 1914 compared with 1915. Massachusetts, Minnesota, and Michigan showed the largest increases.

Sand-lime brick, one of the latest aspirants among building materials for public favor, after the vicissitudes natural to the introduction of a new material, appears to have found for itself a secure foothold in the building world and will no doubt increase in popularity. Some of the plants that were failures in the hands of the original owners have been acquired by successful operators and either remodeled or combined with operating concerns, and other plants are increasing their capacity to meet the expected demand in 1916.

The following tables show the value of sand-lime brick sold from the first year for which statistics were collected by the Survey and the quantity and value of sand-lime brick sold in 1914 and 1915 by States. In 1915 there were less than three operators in each of 11 States, and therefore in order to avoid the disclosure of confidential returns made to the Survey the figures showing the sales in these States have been combined opposite the item "Other States."

In 1915, as for a number of years, Michigan was the leading State in sales of sand-lime brick, reporting over 25 per cent of the quantity and value of all sales; Minnesota was second and New York was third. In value the common brick constituted 96 per cent of the total value in 1915.

The average price per thousand for common brick in 1915 was $6.22, compared with $5.99 in 1914. For front brick the average price was $10.21 in 1915, compared with $9.08 in 1914.

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Sand-lime brick sold in the United States, 1903–1915.

Year.	Number of active firms reporting.	Value of product.	Year.	Number of active firms reporting.	Value of product.
1903	16	$155,040	1910	76	$1,169,153
1904	57	463,128	1911	66	897,664
1905	84	972,064	1912	71	1,200,223
1906	87	1,170,005	1913	68	1,238,325
1907	94	1,225,769	1914	62	1,058,512
1908	87	1,029,699	1915	56	1,135,104
1909	74	1,150,580			

Sand-lime brick sold in the United States in 1914 and 1915.

State.	1914.[a]			1915.[b]		
	Number of active firms reporting.	Quantity (thousand).	Value.	Number of active firms reporting.	Quantity (thousand).	Value.
California	4	1,484	$15,387	3	1,533	$12,158
Florida	4	18,476	105,435	4	[c] 13,078	[c] 77,575
Idaho	3	1,670	17,466	[d]	[d]	[d]
Indiana	4	16,288	76,175	3	6,491	31,702
Massachusetts	4	3,530	28,713	4	13,362	101,250
Michigan	12	42,465	255,784	11	47,285	286,948
Minnesota	4	19,958	119,271	4	26,489	151,128
New York	4	18,347	107,633	3	[c] 16,504	[c] 121,114
Pennsylvania	3	9,960	54,418	3	10,573	56,843
South Dakota	3	3,864	27,665	3	2,554	18,402
Texas	[d]	[d]	[d]	3	6,581	52,941
Wisconsin	4	14,588	86,682	4	17,161	94,064
Other States [e]	13	[c] 21,999	[c] 163,883	11	18,032	130,974
	62	172,629	1,058,512	56	179,643	1,135,104

[a] Common brick except 7,630,000 front brick, valued at $69,263, made in the following States: California (693,000, valued at $9,105), District of Columbia, Florida (1,367,000, valued at $11,115), Idaho, Indiana, Massachusetts, Michigan, Minnesota, Nebraska, New Jersey, New York, Oklahoma, South Dakota, and Wisconsin.

[b] Common brick except 4,120,000 front brick, valued at $42,080, made in the following States: California, Florida (813,000, valued at $7,440), Indiana, Kentucky, Massachusetts, Michigan, Minnesota, Nebraska, New York, Texas, and Wisconsin.

[c] Includes fancy brick.

[d] Included in "Other States."

[e] Includes, 1914: Colorado, District of Columbia, Georgia, Iowa, Kentucky, Nebraska, New Jersey, North Dakota, Ohio, Oklahoma, Texas, Washington; 1915: Connecticut, District of Columbia, Georgia, Idaho, Iowa, Kentucky, Nebraska, New Jersey, North Dakota, Ohio, and Washington.

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FULLER'S EARTH.

By JEFFERSON MIDDLETON.

INTRODUCTION.

The fuller's earth industry continued to show progress in 1915, the product marketed increasing in both quantity and value. The increase in quantity was 6,920 short tons, or 17 per cent, and in value $85,573, or 21 per cent, over 1914, the year of largest production and value prior to 1915. Imports of fuller's earth decreased in 1915 compared with 1914 22 per cent in both quantity and value. Almost from the inception of the industry in this country the domestic production and value and the average price per ton have exceeded those of imports. In 1915 the quantity of domestic earth marketed was more than twice as great as that imported, the value of the domestic output was more than three times that of the imports, and the average price per ton of domestic earth was $2.37 (nearly a third) more than that of the imported earth.

The European war, which has curtailed imports of fuller's earth, has been a contributing cause to this increase in 1915 in the sales of domestic material.

During the early years of the industry the domestic earth was used only for filtering mineral oil, for which it was found superior to the imported earths. Operators in nearly every producing State now report that domestic earth is used also for filtering vegetable oils and animal fats. The increasing use of American earth for these purposes and the fairly steady though gradual growth of the industry are features that speak well for its prosperity.

OCCURRENCE.

Fuller's earth occurs in Alabama, Arizona, Arkansas, California, Colorado, Florida, Georgia, Massachusetts, Minnesota, Mississippi, Nebraska, New York, South Carolina, South Dakota, Texas, Utah, and Virginia; but it was mined and marketed in 1915 in only six States, namely, Arkansas, California, Florida, Georgia, Massachusetts, and Texas, a decrease from 1914 of one State—Colorado. The South produced practically all the domestic fuller's earth marketed, more than 98 per cent in 1915 coming from that region.

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USES.

Fuller's earth obtains its name from its original use in fulling cloth. Little domestic earth is now used in this country for that purpose, the principal use being in bleaching, clarifying, or filtering fats, greases, and oils. It is also used in the manufacture of pigments for printing wall papers, for detecting certain coloring matters in some food products and as a substitute for talcum powder.[1]

PRODUCTION.

The growth of the industry since 1895, when it assumed commercial importance, is shown in the first of the following tables. The steady growth of this industry is evident, the production being nearly seven times as great and the value more than 11 times as great in 1915 as in 1895. The average price per ton has on the whole increased, although the lowest price ($5.72) was in 1904. The average price in 1915, $10.21 per ton, was the highest attained for domestic earth and was 36 cents higher than that of 1914.

Fuller's earth marketed in the United States, 1895–1915.

Year.	Quantity (short tons).	Value.	Average price per ton.	Year.	Quantity (short tons).	Value.	Average price per ton.
1895	6,900	$41,400	$6.00	1906	32,040	$265,400	$8.28
1896	9,872	59,369	6.01	1907	32,851	291,773	8.88
1897	17,113	112,272	6.56	1908	29,714	278,367	9.37
1898	14,860	106,500	7.17	1909	33,486	301,604	9.01
1899	12,381	79,644	6.43	1910	32,822	293,709	8.95
1900	9,698	67,535	6.96	1911	40,697	383,124	9.41
1901	14,112	96,835	6.86	1912	32,715	305,522	9.34
1902	11,492	98,144	8.54	1913	38,504	369,750	9.58
1903	20,663	190,277	9.20	1914	40,981	403,646	9.85
1904	29,480	168,500	5.72	1915	47,901	489,219	10.21
1905	25,178	214,497	8.52				

Fuller's earth marketed in the United States, 1914–1915.

	1914				1915			
	Number of operators.	Quantity (short tons).	Value.	Average price per ton.	Number of operators.	Quantity (short tons).	Value.	Average price per ton.
Eastern States [a]	7	39,259	$388,959	$9.91	7	45,941	$470,648	$10.24
Western States [b]	7	1,722	14,687	8.53	5	1,960	18,571	9.48
	14	40,981	403,646	9.85	12	47,901	489,219	10.21

[a] Includes Florida, Georgia, and Massachusetts.
[b] Includes, 1914: Arkansas, California, Colorado, and Texas; 1915: Arkansas, California, and Texas.

The small number of producers makes it impossible to publish totals for some States without disclosing confidential reports; consequently the distribution of output is given by Eastern and Western States. The eastern section continues to produce by far the larger part of the fuller's earth marketed, its seven operators reporting approximately 96 per cent of the quantity and value of the entire output in both 1914

[1] Bur. Mines Bull. 71, p. 19, 1913.

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and 1915. Named in the order of their rank, the producing States were Florida, Georgia, Arkansas, Texas, Massachusetts, and California. Florida and Georgia together contributed about 95 per cent of the total in 1915. Both sections of the country showed an increase in value and average price per ton.

THE FULLER'S EARTH INDUSTRY.

Arkansas.—Only one fuller's earth mine was operated in Arkansas in 1915, that of John Olsen, at Klondyke, Saline County. The earth from this mine is used for refining edible oils and animal fats. It was in this State that fuller's earth was first discovered in the United States, the discovery having been made by Mr. Olsen in 1891.

California.—In California, two operators reported sales in 1915, a decrease of two from 1914. California fuller's earth is used in refining mineral and vegetable oils and animal fats. Notwithstanding the large production of petroleum in California, there appears to be only a small quantity of local fuller's earth used in refining petroleum. There are many deposits in the State that could be easily made available for this purpose, should the demand justify their development.

Florida.—Florida was the leading State in 1915, as it has been since the beginning of the industry in this country, reporting nearly 75 per cent of the total quantity and value. The average price per ton of Florida earth in 1915 was $10.36, compared with $10.07 in 1914. The Florida earth is used principally in refining mineral oils.

Georgia.—There are two operators in Georgia, both of whom were active in 1915, reporting business good. Georgia earth is used in refining mineral and vegetable oils and fats.

Massachusetts.—Only one firm has produced fuller's earth in Massachusetts for several years. This earth is used in fulling cloth and is the only earth produced in the United States that is reported as being used for that purpose. It is also used in the manufacture of grinding wheels.

Texas.—Two operators reported sales of fuller's earth in 1915. This earth has been used in filtering mineral and vegetable oils, filtering chemicals, and in paint manufacture. There has been considerable activity in this State in prospecting, and earths have been discovered which appear to be of high quality.

IMPORTS.

The imports for consumption of fuller's earth in 1915 fell off considerably, after having reached their maximum in quantity and value in 1914; the decrease in both quantity and value was 22 per cent, or 5,536 tons and $42,590. The average price per ton was 3 cents higher than in 1914 and was the same as in 1913—$7.84. The imports are nearly all (about 96 per cent) of wrought or manufactured earth.

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Fuller's earth imported for consumption into the United States, 1897–1915.

Year.	Unwrought or unmanufactured.			Wrought or manufactured.			Total.		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
1897[a]	2,585	$14,283	$5.53	2,395	$20,037	$8.37	4,980	$34,320	$6.89
1898	2,283	15,921	6.97	7,073	55,123	7.79	9,356	71,044	7.59
1899	4,192	23,194	5.53	7,366	46,446	6.31	11,558	69,640	6.03
1900	2,723	14,750	5.42	6,431	50,047	7.78	9,154	64,797	7.08
1901	3,266	17,230	5.28	8,792	63,467	7.22	12,058	80,697	6.69
1902	4,239	26,635	6.28	10,895	75,945	6.97	15,134	102,580	6.78
1903	4,260	28,339	6.65	12,840	92,332	7.19	17,100	120,671	7.06
1904	1,975	9,546	4.83	8,247	64,460	7.82	10,222	74,006	7.24
1905	1,705	12,798	7.51	12,858	93,199	7.25	14,563	105,997	7.28
1906	2,905	20,129	6.93	11,920	88,566	7.43	14,825	108,695	7.33
1907	2,490	16,833	6.76	13,916	105,388	7.57	16,406	122,221	7.45
1908	2,363	16,242	6.87	9,803	77,171	7.87	12,166	93,413	7.68
1909	1,802	12,492	6.93	10,950	88,659	8.10	12,752	101,151	7.93
1910	2,160	14,399	6.67	14,427	118,146	8.19	16,857	132,545	7.86
1911	1,881	10,877	5.78	16,343	132,717	8.12	18,224	143,594	7.88
1912	1,970	11,619	5.90	17,139	133,718	7.80	19,109	145,337	7.61
1913	1,916	12,344	6.44	16,712	133,657	8.00	18,628	146,001	7.84
1914	1,468	9,283	6.32	23,509	185,800	7.90	24,977	195,083	7.81
1915	850	5,176	6.09	18,591	147,317	7.92	19,441	152,493	7.84

[a] July to December

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ASBESTOS.

By J. S. Diller.

PRODUCTION.

The United States marketed a domestic production of 1,731 short tons of asbestos in 1915, valued at $76,952. As compared with the production of 1914, this represents a gain of 484 tons, or 39 per cent, in quantity, and of $57,987, or 306 per cent, in value. The great increase in value was due to the high grade of the material produced.

The producing States were Georgia, Arizona, and California. There were three important producers, two in Georgia and one in Arizona, besides several small producers in California. Georgia had much the largest production, a gain of 22 per cent in 1915 over 1914, but yields only mass fiber of the hornblende variety, which is relatively of low grade, can not be spun, and is practically all milled to one grade suitable for use in the manufacture of fireproof material. Arizona produces chrysotile only of the cross-fiber type and of spinning grade. The production of Arizona in 1915 was more than 10 times the quantity produced in 1914, and this accounts for the much greater increase in value than in quantity, as compared with the total output for 1914.

The average annual production of asbestos in the United States (for the last 26 years) from 1890 to 1915, inclusive, has been 1,470 short tons, ranging from a minimum of 50 tons in 1893 to a maximum of 7,604 tons in 1911. In 1911 and 1912, when there was a large production in Vermont, the total value of the output exceeded that of the production in 1915. But on account of the high grade of the Arizona asbestos the average value per ton in 1915 was $44.46, against $15.77 and $19.98, respectively, in 1911 and 1912.

PRICES.

The principal source of the asbestos sold in the United States is in Quebec, Canada, where also prices are controlled. The average price in New York, as shown in the accompanying table, has been gradually rising, especially for the higher grades, and the rise continues. Early in April, 1915, No. 1 crude was selling as high as $500 a ton, and No. 2 at $300.

Range of New York prices per short ton for Canadian chrysotile fiber, 1912–1915.

	1912	1913	1914	1915
No. 1 crude	$300–$325	$320–$350	$350–$375	$350–$400
No. 2 crude	175– 200	200– 225	225– 250	225– 275
No. 1 fiber	.....	100– 125	100– 125	110– 150
No. 2 fiber	.....	75– 100	75– 100	80– 125
Shorter fibers	.....	10– 30	10– 30	10– 30

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IMPORTS.

The principal source of the world's supply of asbestos is Canada. The United States, being Canada's nearest neighbor and having every facility for intercourse, has naturally become the greatest importer of raw material from Canada and the largest manufacturer of asbestos products.

Unmanufactured asbestos is admitted to the United States free, but manufactured asbestos is dutiable at from 25 to 40 per cent ad valorem.

As shown in the accompanying table, the imports of manufactured asbestos from Canada in 1915 were nearly 34 per cent greater than in 1914; but it is not certain how much of the imported material remained in the United States for consumption and how much was reshipped to other countries.

It is of interest to note that practically all the imported unmanufactured asbestos came from Canada, but that manufactured products of asbestos were imported from 10 countries.

Asbestos imported into the United States, 1914 and 1915.

[Figures furnished by United States Department of Commerce, April, 1916.]

Country.	1914			1915		
	Unmanufactured.		Manufactures of	Unmanufactured.		Manufactured.
	Quantity (short tons).	Value.	Value.	Quantity (short tons).	Value.	Value.
Austria-Hungary			$47,982			$10,502
Belgium			20,267			
Canada	71,781	$1,393,732	19,007	93,565	$1,980,749	1,867
Cuba						538
Denmark						49
England			159,098			106,412
France			2,863			139
Germany	11	2,209	104,368	1	734	14,117
Ireland			236			
Italy	2	631	8,020			2,624
Mexico			130			
Netherlands						190
Russia in Europe	72	11,186				
Scotland			1,389			879
Switzerland			4,984			
	71,866	1,407,758	368,344	93,566	1,981,483	137,317

ASBESTOS IN THE UNITED STATES.

ARIZONA.

The asbestos industry of Arizona is developing steadily. Production began in 1914 and increased more than tenfold in 1915. The Arizona Asbestos Association is the only producer, and the map, figure 5, shows the location of the mine at Ash Creek.

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The shipments have all been as No. 1 crude, and in the mining a large tonnage of milling rock of shorter fiber has been accumulated. A small experimental mill has been erected and a road completed to the mine, where more than 4,000 feet of tunnels have been developed in the canyon walls. Shipments are said[1] to average a ton a day, going out on burros to Globe and to Rice on the Arizona Eastern Railroad. The mode of occurrence of the asbestos has been illustrated and described in the report for 1914.[2]

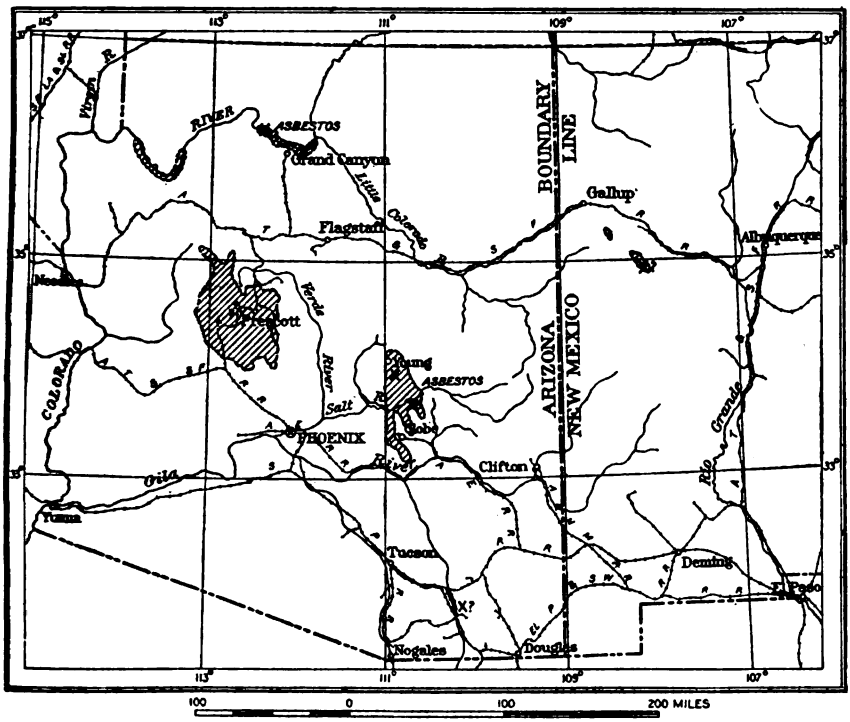

FIGURE 5.—Map showing asbestos mines (☭) and prospect (×) in Arizona. Shading shows areas of pre-Cambrian rocks.

The success of the Ash Creek mine has greatly encouraged prospectors, and many claims, estimated at approximately 500, have recently been taken up, for the most part in the area marked on the map (see fig. 5) between Young and Salt River and north of Globe. Among the principal locators may be mentioned Fred Patee, J. I. Cooper, R. R. Jackson, C. F. Sloane, John Armour, Hardeman & Wolf, Fraser & Tenbrook, and J. K. Burch.

Arizona is a promising asbestos field, and, with the development of greater facilities for transportation, the output is destined to be

[1] Eng. and Min. Jour., Dec. 11, 1915, p. 985.
[2] U. S. Geol. Survey Mineral Resources, 1914, pp. 96-97, 1915.

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much larger than now. The high grade of the material will always keep it in lively demand, especially for use in electrical appliances. The method of mining is in strong contrast to that of Canada, where open-quarry methods obtain. Notwithstanding the active development of the asbestos interests in south-central Arizona, there has been but little activity in the Grand Canyon region, where this valuable asbestos was first discovered.

CALIFORNIA.

California contains many masses of serpentine, and there has been much prospecting in them for asbestos, but the deposits found and exploited thus far are of little consequence and the production has been small. The recent developments on Meares Creek, in Shasta County, and east of Carville, in Trinity County, have attracted considerable local attention, but have resulted in no definite production. These localities were noted in the Geological Survey reports on asbestos for 1913 and 1914.

A company in Oakland that manufactures asbestos pipe and boiler covering, asbestos paper, shingles, and lumber, reports having purchased and used in 1915, 80 tons of asbestos produced in Placer, Alameda, and Contra Costa counties, at an average price of $20 a ton. This may not be the total production of the State, but it is the only production of which the Geological Survey is aware, and it indicates an increase of 15 tons in the production reported by the same company in 1914 from Shasta, Placer, Calaveras, and Alameda counties.

GEORGIA.

Georgia produces far more asbestos than any other State. The asbestos is of the amphibole variety and of the mass-fiber type, in which 90 per cent of the rock quarried appears in the finished product; it can therefore be produced at much lower cost than other asbestos. It is all ground and fiberized to practically one grade suitable for the manufacture of cements, plasters, shingles, and asbestos lumber. There are two companies operating, the Sall Mountain Co., of Chicago, with mine near Cleveland and mill at Gainesville, Ga., and the Asbestos Mining & Manufacturing Co., of Atlanta, Ga., with its mine and mill at Hollywood.

ASBESTOS IN FOREIGN COUNTRIES.

CANADA.

The most productive asbestos field in the world is in the Province of Quebec, Canada, and the chief points of production are Thetford, Black Lake, and Danville.

The industry has been developed rapidly to a production sold in 1915 of 113,115 tons, valued at $3,491,450.[1] Of the quantity sold 84,584 tons, valued at $2,734,695, was exported and by far the larger

[1] Preliminary report on the mineral production of Canada, 1915. Statistics subject to revision.

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part came to the United States, where many of the mines are owned and where the asbestos is manufactured.

Output, sales, and stocks of Canadian asbestos in 1915.

	Output.	Sales.			Stock on hand Dec. 31.		
	Quantity (short tons).	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.	Value per ton.
Crude No. 1	2,305.6	2,735.4	$749,811	$274.11	589.8	$176,533	$299.31
Crude No. 2	1,681.6	2,631.3	322,049	122.39	316.6	43,006	135.84
Mill stock No. 1	21,710	24,238	1,270,074	52.40	2,176	91,919	42.24
Mill stock No. 2	41,973	42,031	840,132	19.99	12,837	268,197	20.89
Mill stock No. 3	38,888	41,479	309,384	7.46	6,133	55,555	9.06
Total asbestos	106,558.2	113,114.7	3,491.450	30.87	22,052.4	635,210	28.80
Asbestic		25,700	21,819	.85			

ACTIVE DEMAND FOR ASBESTOS IN APRIL, 1916.

As has been indicated above, the asbestos of the world is supplied chiefly by Canada. Most of it is exported free of duty to the United States, the greatest manufacturer and user of asbestos products.

An order in council by the Government at Ottawa, Canada, March 25, 1916, placed an embargo on the shipment of asbestos from Canada to other than British ports, but permitted shipments to the allied countries, France, Russia, Italy, Japan, and Portugal, all special licenses being granted by the British consul. As this absolutely shut out the consumers of asbestos in the United States, it was demonstrated to the Government at Ottawa that this would work a great hardship on American manufacturers and consumers, and the embargo has consequently been modified to the extent of permitting shipments of crude asbestos to enter the United States on the guaranty from the manufacturers and in turn from their customers that none of the crude or manufactured material will be reexported from the United States, except as provided for in the original circular.

The embargo and the requirement of a guaranty as to the ultimate destination of the asbestos have caused asbestos users in the United States to look for an available domestic supply.

In 1915 there was a great increase in the production of high-grade asbestos in Arizona, as elsewhere mentioned, the occurrence of which has been described in recent Geological Survey reports on asbestos. The bulk of the output and the lower-grade material come from Georgia. Both Arizona and Georgia are capable of increasing their output.

Some years ago (1911) Vermont had a productive mine, largely of chrysotile, in the same belt of rocks that contain the rich deposits of asbestos in Canada. For the last few years the mine has not been in operation, but now as a result of the embargo it may again become an important source of supply.

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Virginia produced in 1905 and 1906 a small quantity of a low-grade asbestos that is still used in the manufacture of a local asbestos product. The fiber is of the amphibole variety, slip-fiber type. It was quarried near Body Camp and hauled 12 miles to mill at Bedford City.

There has been much excitement and speculation concerning the asbestos in the Casper Mountain and other regions in Wyoming. Some mills have been erected. There has been no definite production, but the quality of the fiber, in part chrysotile, is locally encouraging. Idaho has in the Kamiah region large deposits of material like that in Georgia. California has produced asbestos, generally of low grade, at a number of places and may yet become important in that respect.

On the whole, the encouraging outlook in Arizona, which includes also the Grand Canyon region, with the possible resumption of production in Vermont and an increased production in Georgia, may be expected to make up at least part of the loss by embargo in Canada.

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SLATE.

By G. F. Loughlin.[1]

PRODUCTION.

GENERAL STATISTICS.

The depression which began to affect the slate industry in October, 1914, continued throughout the greater part of 1915, and the total value of slate sold in the latter year decreased 13 per cent. For the first time since 1901 the total value of slate sold fell below $5,000,000. Roofing slate decreased 5 per cent in quantity and 10 per cent in value. For the first time since 1898 the number of squares sold was less than 1,000,000 and for the first time since 1900 their value fell below $4,000,000. Mill stock decreased nearly 15 per cent in quantity and 17 per cent in value, the lowest value since 1908. Blackboard material and school slates ("other uses") decreased nearly 31 per cent.

Comparison of the slate sold in 1915 with that sold in the eight preceding years is shown in the following table:[2]

Slate sold in the United States, 1907–1915.

Year.	Roofing slate.			Mill stock.			Other uses (value).	Total value.
	Number of squares (100 sq. ft.).	Value.	Average price per square.	Quantity (square feet).	Value.	Average price per square foot.		
1907	1,277,554	$4,817,769	$3.77	5,979,624	$943,409	$0.157	$258,042	$6,019,220
1908	1,333,171	5,186,167	3.89	4,793,812	793,304	.165	337,346	6,316,817
1909	1,133,713	4,394,597	3.87	5,112,894	876,089	.171	170,732	5,441,418
1910	1,260,621	4,844,664	3.84	5,181,498	999,098	.192	392,997	6,236,759
1911	1,124,677	4,348,571	3.87	5,744,577	1,027,605	.178	351,843	5,728,019
1912	1,197,288	4,636,185	3.87	5,765,273	1,013,220	.176	393,913	6,043,318
1913	1,113,944	4,461,062	4.00	6,312,011	1,233,838	.195	480,576	6,175,476
1914	1,019,553	4,160,832	4.08	5,361,925	977,930	.182	[a] 568,025	5,706,787
1915	967,880	3,746,334	3.87	4,576,112	819,672	.179	[a] 392,909	4,958,915

[a] Includes in 1914, 4,043,043 school slates, valued at $35,205, and 4,201,057 square feet of blackboard material, valued at $526,846; in 1915, 4,843,432 school slates, valued at $38,167, and 3,152,771 square feet of blackboard material, valued at $349,959.

The producing States in 1915 were the same as in 1914 and maintained the same rank; but, as shown in the table below, not all were

[1] All the tables in this report, as in previous reports on slate, have been compiled by Miss A. T. Coons from figures reported by the producers directly to the United States Geologicial Survey.

[2] The values in this table and succeeding tables represent prices f. o. b. at point of shipment.

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equally affected by the general conditions of the year. In Maryland and New York there were substantial increases and in Virginia a small increase in value of slate sold; in the other States there were decreases.

Slate sold in the United States, 1911–1915, by States.

State.	1911	1912	1913	1914	1915	Percentage of increase or decrease.
Arkansas	(a)	(a)				
Georgia	(a)		(a)			
Maine	$263,516	$282,678	$323,998	$277,419		
Maryland	76,035	92,184	83,993	77,391	$91,277	+17.9
New Jersey	(a)	(a)	(a)	(a)	(a)	
New York	120,359	135,207	144,882	112,776	127,603	+13.1
Pennsylvania	3,431,351	3,474,247	3,733,581	3,609,959	3,044,269	−15.7
Utah				(a)	(a)	
Vermont	1,624,941	1,849,975	1,697,820	1,414,247	1,234,891	−12.7
Virginia	188,308	195,392	175,330	204,139	210,612	+ 3.2
Other States	*b* 23,009	*c* 13,685	*d* 15,372	*e* 10,856	*f* 250,263	
	5,728,019	6,043,318	6,175,476	5,706,787	4,958,915	−13.1

a Included in "Other States."
b Includes Arkansas, Georgia, and New Jersey.
c Includes Arkansas and New Jersey.
d Includes Georgia and New Jersey.
e Includes New Jersey and Utah.
f Includes Maine, New Jersey, and Utah.

Conditions in the different States are shown in detail in the following table:

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Slate sold in the United States in 1914 and 1915, by States, and uses.

1914.

State.	Number of operators.	Roofing slate.			Mill stock.[a]						Other.	Total value.
					Manufactured.		Rough.		Total.			
		Number of squares (100 square feet).	Value.	Average price per square.	Quantity (square feet).	Value.	Quantity (square feet).	Value.	Quantity square feet).	Value.		
Maine	4	15,282	$88,527	$5.79	417,236	$188,892	.....	.....	417,236	$188,892	.....	$277,419
Maryland	3	13,333	75,747	5.68	.....	.....	.....	.....	.....	.....	$1,644	77,391
New Jersey	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(b)
New York	10	24,059	110,500	4.59	15,000	2,250	51	$26	15,051	2,276	.....	112,776
Pennsylvania	84	614,863	2,463,944	4.01	3,272,891	540,791	673,685	39,624	3,946,576	580,415	[c]565,600	3,609,959
Utah	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(b)
Vermont	46	306,190	1,207,419	3.94	843,344	185,205	139,718	21,142	983,062	206,347	481	1,414,247
Virginia	7	43,312	204,139	4.71	.....	.....	.....	.....	.....	.....	.....	204,139
Other States[d]	3	2,514	10,556	4.20	.....	.....	.....	.....	.....	.....	300	10,856
	157	1,019,553	4,160,832	4.08	4,548,471	917,138	813,454	60,792	5,361,925	977,930	568,025	5,706,787

1915.

Maine	3	14,257	$83,919	$5.89	.....	.....	.....	.....	.....	.....	.....	(b)
Maryland	3	14,912	89,589	6.01	.....	.....	.....	.....	.....	.....	$1,688	91,277
New Jersey	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(b)
New York	10	29,226	127,603	4.36	.....	.....	.....	.....	.....	.....	.....	127,603
Pennsylvania	81	574,223	2,142,173	3.71	2,987,872	$479,254	567,526	$32,618	3,555,398	$511,872	[e]390,224	3,044,269
Utah	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(b)
Vermont	41	284,362	1,085,887	3.82	537,734	130,221	125,069	18,186	652,803	148,407	597	1,234,891
Virginia	8	49,208	210,612	4.27	.....	.....	.....	.....	.....	.....	.....	210,612
Other States[d]	.....	1,592	6,551	4.12	367,911	159,393	.....	.....	367,911	159,393	400	250,263
	150	967,880	3,746,334	3.87	3,893,517	768,868	692,595	50,804	4,576,112	819,672	392,989	4,958,915

[a] Mill stock is classed as rough or manufactured according to the condition in which it is sold by the quarrymen; whether as rough blocks to slate mills or in finished or partly finished condition from the producers' mills at the quarries.

[b] Included in other States.

[c] Composed of 4,043,043 school slates, valued at $35,205; 4,021,057 square feet of blackboard material, valued at $526,846; and slates used for structural and other purposes, valued at $3,549.

[d] Includes, in 1914, New Jersey and Utah; in 1915, Maine, New Jersey, and Utah.

[e] Composed of 4,843,432 school slates, valued at $38,167; 3,152,771 square feet of blackboard material, valued at $349,959; and slate used for other purposes, valued at $2,098.

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The number of active producers, which had decreased from 171 in 1913 to 157 in 1914, decreased to 150 in 1915. Virginia was the only State in which the number increased. Of the States producing roofing slate, Maryland gained not only in quantity and value but also in price per square of slate sold; New York and Virginia gained in quantity and value, but the price per square decreased in each State; Pennsylvania and Vermont, which together yielded more than 86 per cent of the total value of roofing slate, decreased in quantity, value, and price per square. In all the States that reported a marketed production of mill stock in 1915 there were decreases in both quantity and value.

The causes of the depressed state of the slate industry in 1915 are largely but not wholly those that affected certain other industries during the year. There was a general lack of demand attributed by the producers to inactivity in building operations, which extended throughout the country until late summer or early fall. Prices were not steady. Some companies, with large stocks on hand, sold their product at lower prices than have prevailed for 10 years; and several companies, unable to withstand the severe competition and the increasing cost of labor and supplies, suspended operations. A few companies were affected by purely local conditions possible in any year, such as falls of rock and inadequate equipment.

For several years slate has suffered from competition with artificial roofing materials, which have been aggressively advertised, and from the increasing number of factories, dwellings, schools, and other buildings that have been built with flat roofs. Some slate producers complain that there is a general apathy on the part of slate companies in meeting these condition; that inadequate advertising of slate is largely responsible for the inroads made by well-advertised artificial materials; and that the failure of companies to cooperate in promoting its development has allowed the slate industry to remain nearly stationary or to decline, while other competing industries have made substantial progress.

It has also been suggested that a failure to recognize a certain minimum thickness for slates has been unfavorable to the industry; that some producers are in the habit of splitting their slates too thin; and that the insistence by architects and the general public on thicker slates would result in much less breakage, a higher standard of splitting and sorting slates, and the marketing of a product of higher grade. The minimum thickness suggested is three-sixteenths of an inch for the strongest slates and fully a quarter of an inch for the common slates of somewhat less strength. The growing demand for thicker slates to produce rough effects should assist in this development of the industry.

A few companies reported a successful year and a demand exceeding supply in 1915. These supplied markets in New York and the Middle Atlantic States, the same region in which depression was most keenly felt by the majority of producers.

Several producers reported that conditions began to improve during the last three months of 1915 and that prices for all kinds of slate early in 1916 were more encouraging than at corresponding periods for several years. The present condition of many quarries is such that they can greatly increase their output to keep pace with any increase in demand.

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COLORED SLATES.

As the red, purple, and green slates of Vermont and New York are much used for special kinds of roofing and for certain kinds of interior work where their colors are appropriate, the following table will be of interest as an index of the trend of this branch of the slate industry:

Colored slates sold in New York and Vermont in 1909, 1914, and 1915.

Year.	Red.	Green.			Purple.	Purple and green, mottled, variegated.
		Sea green.	Unfading green.	Green.		
1909	$37,789	$758,372	$183,135	$246,612	$145,041	$443,430
1914	36,256	789,055	81,884	190,265	121,935	307,628
1915	28,228	672,917	71,765	191,573	88,987	303,199

The value of red slate, which has been sold wholly for roofing during recent years, was not much less in 1914 than in 1909, and the value of sea-green slate, also sold wholly for roofing, increased. The great fall in value of unfading green slate is in large part due to the fact that one company that quarried this variety in 1909 has been working a band of mixed purple and green slate during the last two years. The values of green, purple, and mottled or variegated slates were all considerably lower in 1914 than in 1909. These, as well as the unfading green, are quarried mostly for roofing slate and only a small quantity is sold as manufactured mill stock. The additional decrease in value of most of these slates in 1915 is attributed to the temporary decline in building operations, which prevailed throughout the greater part of the year.

The prices of these slates tends to vary inversely as their total values. Sea-green slate, the cheapest grade, has during the last two years more than doubled any other grade in value. The mottled or variegated and the unspecified green slates are the next lowest in price and are second and third, respectively, in value. Unfading green, the highest grade of green slate, is in much less demand, and red slate, the most costly to work and the highest of all in price, is by far the lowest in value. Prices of these slates range from about $3 per square for the sea-green to about $9 for the red slate.

EXPORTS.

The value of the exports of roofing slate, which was $226,413 in 1913 and $139,125 in 1914, was only $46,137 in 1915, the lowest recorded since 1895. England, which has heretofore been the largest user of American roofing slate, did not import any in 1915; neither did Belgium, Germany, nor the Netherlands. No record of exports of mill stock is available, as such exports have been included by the Bureau of Foreign and Domestic Commerce, United States Department of Commerce, with "Stone for other uses." One company in Maine reported that slate slabs to the value of $2,385 were exported to Denmark and to the value of $358 to Russia in 1915. A great many electrical switchboard panels are probably exported annually by the large electrical companies and listed under electrical supplies.

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Roofing slate exported from the United States, 1915.

[Figures furnished by the Bureau of Foreign and Domestic Commerce, U. S. Dept. Commerce.]

Canada	$31,101	West Indies:	
Mexico	2,710	Cuba	$2,740
Central America:		Dominican Republic	333
British Honduras	68	Dutch West Indies	106
Costa Rica	833	Europe:	
Honduras	28	Italy	251
Nicaragua	27	Scotland	940
Panama	559	British South Africa	2,288
South America:		Australia	2,621
Brazil	75	New Zealand	486
British Guiana	208		46,137
Chile	239		
Colombia	16		
Trinidad	499		
Venezuela	9		

Next to the United States, Great Britain and France are the chief slate-producing countries; Belgium ranks next; and Germany (Bavaria) and Canada also report production. As all these countries have been directly or indirectly involved in the European war during the last year, both their production of slate and their demand for it have doubtless been greatly decreased. Canada's production decreased from 1,075 squares, valued at $4,837, in 1914 to 397 squares, valued at $2,039, in 1915.[1] The failure of the United States to export a considerable quantity under these conditions points to a world-wide decline in building operations requiring this material.

IMPORTS.

Imports of slate into the United States have for many years been insignificant. In 1914 and 1915 the total values of imported slate were, respectively, $4,855 and $2,768. Imports from Great Britain and Ireland, according to the Slate Trades Gazette, amounted to 20 tons, valued at $463, of which 1 ton, valued at $94, was shipped to the Atlantic coast, and 19 tons, valued at $369, to the Pacific coast.

SLATE INDUSTRY, BY STATES.

The domestic production of slate in 1915, as shown in the tables on pages 19–21, was confined to Eastern and New England States, which supplied markets on the Pacific coast as well as in the Central and Southern States. Scattered deposits have been more or less developed in Arizona, Arkansas, California, Colorado, Georgia, and Tennessee, and a little work was done on some of them in 1915, but no sales of slate were reported. Conditions in the producing States are summarized in the following paragraphs.

MAINE.

The value of slate sold by producers in Piscataquis County, Maine, in 1915 was 12 per cent less than in 1914. The greater part was in manufactured mill stock, but as this product was reported by only

[1] McLeish, John, Preliminary report on the mineral production of Canada during the calendar year 1915: Canada Dept. Mines, Mines Branch, No. 408, pp. 6, 27, 1916.

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two companies in 1915 its value is included in that of "Other States." Much of the mill stock is used for electrical purposes, for which it is especially adapted.

Three of the four companies in the State were active in 1915.

The property of the Maine Slate Co., of Monson, was taken over early in 1916 by the Monson Lustre Slate Co. The new company is planning to operate with electric power and to adopt underground methods of mining, thereby decreasing the percentage of waste. Recent tests of this company's slate by Prof. Frank P. McKibben yielded the following results:

Tests of slate from Monson Lustre Slate Co.

[Average of 10 samples.]

Length (inches).	Width (inches).	Thickness (inch).	Breaking load (pounds).	Modulus of rupture (pounds per square inch).	Maximum center deflection (inch).
24.13 to 24.25 24.25	12.25 to 12.31 12.25	0.23 .163	203 97	10,677 10,320	0.222 .24

Color, use, and producers of slate in Piscataquis County, Maine.

Color or shade.	Use.	Location of quarry.	Trade name of producer.
Dark gray	Roofing	Brownville	The Merrill-Brownville Slate Co.
Unfading blue black, with luster.	do	Monson	Monson Lustre Slate Co. (Maine Slate Co. of Monson).
Black	Roofing, electrical, and structural.	do	Monson Maine Slate Co.
Gray black; when oiled called black.	Electrical	do	Portland-Monson Slate Co.

MARYLAND.

Maryland was one of the three States whose value of slate sold increased in 1915. Its increase was nearly 18 per cent, more than doubly offsetting the 8 per cent decrease reported in 1914. The same three companies named below were reported active in both 1914 and 1915. Production was handicapped by falls of rock and other local conditions, but one company reported demand to be in excess of production. These companies all operate in the "Peach Bottom" district, which extends from Harford County, Md., into York County, Pa. The slate has been used almost entirely for roofing.

Color, use, and producers of slate in Harford County, Md.

Color or shade.	Use.	Location of quarry.	Trade name of producer.
Blue black	Roofing	Cardiff	Baltimore Peach Bottom Slate Co. and Proctor Slate Manufacturing Co.
Lustrous blue black	do[a]	do	Peach Bottom State Co.
Dark blue or black	do	do	Peerless Slate Co.

[a] Suitable for mill stock, but not much used.

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NEW JERSEY.

The two companies named below continued to sell roofing slate in 1915 as in 1914. Conditions were reported not so good as in 1914.

Color, use, and producers of slate in Sussex County, N. J.

Color or shade.	Use.	Location of quarry.	Trade name of producer.
Blue-black	Roofing	La Fayette	La Fayette Slate Co.
Do	do	Newton	Newton Slate Co.

NEW YORK.

Ten of the thirteen companies produced slate in New York in 1915 as in 1914, and the total value of the slate sold increased 13 per cent, which partly offset the decrease of 22 per cent in 1914. The New York slate quarries are in Washington County, adjacent to the slate-producing region of Rutland County, Vt., The slate includes red, green, purple, variegated, and black varieties, and is almost entirely used for roofing. A little of the red variety has been used in the manufacture of paint. As there is a considerable difference in price between red and green slate, fluctuation in the marketed production of either causes considerable variation in the yearly average price of New York slate.

Color, use, and producers of slate in Washington County, N. Y.

Color or shade.	Use.	Location of quarry.	Trade name of producer.
Red	Roofing	Hampton	Imperial Red Slate Co.
Do	do	Hebron	Mathews Slate Co.; Nelson & Guthrie.
Do	do	Middle Granville	E. J. Johnson Quarrying Co.
Do	Roofing and paint.	North Granville	Algonquin Red Slate Co.
Sea-green	Roofing	Granville	Progressive Slate Co.; H. G. Williams.
Green	do	Hebron	John J. McDonough.
Do	do	Jamesville	Durick-Keenan Co. (Inc.).
Do	do	Middle Granville	H. C. McDonough; Jno. E. Williams & Co.
Variegated	do	Jamesville	Durick-Keenan Co. (Inc.).
Do	do	Middle Granville	H. C. McDonough.
Purple	do	do	Do.
Dark purple	do	do	M. Corcoran Co.; Jno. E. Williams & Co.
Black	do	Granville	Connor Williams Slate Co.
Do	do	Middle Granville	H. C. McDonough.

PENNSYLVANIA.

The value of the slate sold by Pennsylvania companies in 1915 decreased 16 per cent from the value in 1914. It amounted to 61 per cent of the total value of the country in 1915. The number of companies reporting activity in 1915 was 81 or 3 less than in 1914; several companies ceased operations during the year, and only one company reported conditions as favorable as usual. Pennsylvania, as shown by the table on page 21, contributes by far the greatest quantity of both roofing slate and mill stock. In 1915 the quantity of its roofing slate sold was 59 per cent and the value was 57 per cent

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of the corresponding totals for the country. The quantity of its mill stock sold, exclusive of blackboards and school slates, was 78 per cent and the value 62 per cent of the corresponding general totals. The percentages of value were somewhat less than in 1914, and the decline is attributed to severe competition for an unusually small amount of trade.

Slate, as in former years, was quarried in Lancaster, Lehigh, Northampton, and York counties, and included gray, bluish-black, and black varieties. The slate of Lehigh and Northampton counties is used for roofing, ordinary mill stock, and also, on account of the fineness of its cleavage, for school slates and blackboards. The value of the slate sold from Northampton County in 1915 was, as shown in the table on page 29, four times that of the slate sold from Lehigh County. York and Lancaster counties produce only roofing slates.

Color, use, and producers of slate in Pennsylvania.

County.	Color or shade.	Use.	Location of quarry.	Trade name of producer.
Dauphin	Dark bluish gray.	.....	Derry Church.	Israel Moyer.
Lancaster	Blue black	Roofing	Peach Bottom.	Gorsuch Bros.
Lehigh	Black	Electrical, blackboards, and structural.	Lynnport	P. A. Leininger.
	do	Electrical and roofing.	Slatedale	Thos. H. Shenton.
	do	Roofing and blackboards.	Slatington	Cambridge Slate Co.
	do	Roofing	do	Empire Slate Co.
	do	Roofing and slate products.	do	Eureka Slate Manufacturing Co. (Ltd.).
	do	Roofing	do	Hazel Dell Slate Co.
	do	Slate products	do	Pennsylvania Slate Co.
	do	Roofing and slate products.	do	Valley Side Slate Co.
	do	do	do	Washington Slate Co.
	Blue black	Roofing	Emerald	Genuine Franklin Slate Co.
	do	Roofing and blackboards.	Slatedale	Ellis Owen Slate Co.
	do	Roofing	do	Ellis Owen Sons Slate Co.
	do	Roofing, blackboards, school slates, electrical, and sanitary.	Slatington	Carbon Slate Co.; Fairview Slate Co.; Slatington Slate Co.
	Dark blue	Roofing	Emerald	Provident Slate Co.
	do	Roofing, blackboards, and school slates.	Slatedale	Provident Slate Co.; Blue Vein Slate Co.
	do	Roofing	Slatington	Big Franklin Slate Co.
	do	Roofing, electrical, blackboards, and structural.	do	Blue Mountain Slate Co.
	Blue	Roofing, electrical, and blackboards.	Slatedale	Thos. H. Shenton.
	do	Roofing	Slatington	Trout Creek Slate Co.
	Gray	Roofing and structural	do	Blue Valley Slate Manufacturing Co.
	Dark gray	Roofing and blackboards.	Slatedale	The Bittner Slate Co.
	Blue gray	Roofing	do	Blumont Slate Co. (Inc.).
Northampton	Dark blue	Roofing	Bangor	Bangor Choice Slate Co.; Bangor Eclipse Slate Co.
	do	Roofing, blackboards, and school slates.	Berlinsville	Provident Slate Co.
	do	Roofing	Chapman Quarries.	The Chapman Slate Co.
	do	do	Nazareth	Estate of A. J. Walker.
	do	do	Pen Argyl	Albion Vein Slate Co.
	do	Roofing and structural	do	Bangor Slate Mining Co.
	do	Roofing, structural, and blackboards.	Windgap	Arvon Slate Co.
	do	Roofing, blackboards, and school slates.	do	W. Evans, jr.
	do	Structural and blackboards.	do	The Excelsior Slate Co.
	Blue	Roofing, structural, and blackboards.	Bangor	Benjamin Slate Co.

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Color, use, and producers of slate in Pennsylvania—Continued.

County.	Color or shade.	Use.	Location of quarry.	Trade name of producer.
Northampton	Blue	Roofing	Bangor	Columbia Bangor Slate Co.
	do	do	Bath	Achenbach Slate Co.
	do	do	Belfast	Northampton Hard-Vein Slate Co.; Theo. Whitesell Co.
	do	do	Berlinsville	Robert Bros.
	do	Roofing, structural, blackboards, and school slates.	Danielsville	Lobb, Parry & Co.; Montgomery Slate Co.
	do	Roofing	Edgemont	Banner Slate Co.
	do	do	Harpers or Flicksville.	True Blue Slate Co.
	do	Roofing, blackboards, and school slates.	Nazareth (near).	Israel Heyer.
	do	Structural and blackboards.	West Pen Argyl.	D. Stoddard & Son.
	Blue black	Roofing	Bangor	American Bangor Slate Co.
	do	do	Berlinsville	Genuine Washington Slate Co.
	do	do	East Bangor	Star Slate Co.
	do	do	Bangor	Bangor Excelsior Slate Co.; Bangor Royal Slate Co.
	do	Roofing, structural, and blackboards.	Bangor (near).	Hammann Slate Co.
	do	Roofing and mill stock.	Bangor	Old Bangor Slate Co.
	do	Roofing	Between Bangor and Windgap.	Jones, Price & Jones.
	do	do	Belfast	Belfast Slate Co.
	do	do	Chapman Quarries.	Keystone Slate Co.
	do	do	Edlemans	Pennsylvania Hard-Vein Slate Co.
	do	Roofing and structural.	Pen Argyl	Albion Slate Co.
	do	Mill stock, blackboards, and roofing.	do	Crown Slate Co.
	do	Roofing and blackboards.	do	Hercules Slate Co.; Stephens, Jackson & Co.
	do	Roofing, structural, and blackboards.	Windgap	Albion Superior Slate Co.
	do	Structural (interior) and blackboards.	do	Phoenix Slate Co.
	Black	Roofing	Bangor	Bangor Central Slate Co.; Bangor Quarry Co.; Bangor Washington Slate Co.
	do	Roofing, mill stock, blackboards, and school slates.	do	North Bangor Slate Co.
	do	Roofing	Bath	Chapman Superior Slate Co.
	do	Roofing, blackboards, and school slates.	Berlinsville	Henry Quarries Co.
	do	Roofing	Chapman Quarries.	Chapman Standard Slate Co.
	do	Roofing, blackboards, and school slates.	Danielsville	Montgomery Slate Co.
	do	Roofing and structural.	East Bangor	East Bangor Consolidated Slate Co.
	do	do	Edgemont	Prudential Slate Co.
	do	Structural and blackboards.	Pen Argyl	Dismond Slate Co.
	do	Roofing, structural, blackboards.	do	Parsons Bros. Slate Co.
	do	Roofing and plumbing slate.	Windgap	Alpha Slate Manufacturing Co.
	do	Roofing, structural, and blackboards.	do	Pen-Bangor or M. L. Tinsman & Co.
York	Dark gray	Roofing	Delta	Delta Slate Corporation.
	do	do	Peach Bottom	W. E. Broome.
	Blue black	do	Delta	R. L. Jones Slate Manufacturing Co.; Miles Peach Bottom Slate Co.
	do	do	Slate Hill	Foulk, Jones & Sons.

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Slate sold in Pennsylvania in 1914 and 1915.

1914.

County.	Number of operators.	Roofing slate.			Millstock.								Other (value).	Total value.
		Number of squares. (100 sq. ft.)	Value	Price per square.	Manufactured.		Rough.		Blackboards.		School slates.			
					Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
					Square feet.		*Square feet.*		*Square feet.*		*Number.*			
Lancaster	2	11,499	$60,360	$6.25										$60,360
York ("Peachbottom slate")	3			5.20										
Lehigh	28	125,148	461,029	3.68	358,891	$44,064	162,549	$15,216	1,711,213	$196,845	3,037,027	$26,897	$1,636	745,687
Northampton	51	478,216	1,942,555	4.06	2,914,000	496,727	511,136	24,408	2,309,844	330,001	1,006,016	8,308	1,913	2,803,912
	84	614,863	2,463,944	4.01	3,272,891	540,791	673,685	39,624	4,021,057	526,846	4,043,043	35,205	3,549	3,609,958

1915.

Lancaster	1	8,034	$45,239	$6.00										$45,239
York ("Peachbottom slate")	3			5.60										
Lehigh	26	113,911	401,345	3.52	334,409	$37,366	140,493	$15,860	905,196	$78,244	3,310,423	$25,861	$1,421	560,097
Northampton	51	452,278	1,695,589	3.75	2,653,463	441,888	427,033	16,758	2,247,575	271,715	1,533,009	12,306	677	2,438,933
	81	574,223	2,142,173	3.71	2,987,872	479,254	567,526	32,618	3,152,771	349,959	4,843,432	38,167	2,098	3,044,269

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UTAH.

In 1915, as in 1914, a small quantity of slate waste taken out in course of development was shipped from the quarry of the Utah Slate Co., near Provo. This was used in combination with asphalt to make sheets, about 12 by 16 inches in size, for roofing purposes.

Color, use, and producers of slate from Utah County, Utah.

Color or shade.	Use.	Location of quarry.	Trade name of product.
Purple	Roofing, structural, and ground.	Provo City	Utah Slate Co.
Green	do	do	Do.
Red	do	do	Do.

VERMONT.

Vermont, second among the slate-producing States and the only State besides Pennsylvania whose annual marketed production exceeds $1,000,000 in value, produced and sold about 25 per cent of the slate sold in the United States in 1915. The value of its slate sold in 1915, as compared with 1914, decreased nearly 13 per cent. The number of producing companies, which had decreased from 53 in 1913 to 46 in 1914, decreased further to 41 in 1915. Roofing slate comprised nearly 88 per cent of the total in value.

Vermont slate quarries are practically all in Rutland County and in the same belt as the New York slate quarries.

Color, use, and producers of slate in Rutland County, Vt.

Color or shade.	Use.	Location of quarry.	Trade name of producer.
Purple	Electrical and roofing	Castleton	Hayes Slate Co.; John Jones Slate Co.
Do	Electrical and billiard tables.	Fair Haven	The Penrhyn Slate Co. (Scotch Hill quarry.)
Do	do	Hydeville	Hydeville Slate Works; The Penrhyn Slate Co. (Cedar Mountain quarry.)
Do	Roofing	Pawlet	O'Brien Bros.
Do	do	Poultney	Estate of William Griffith.
Do	Electrical and billiard tables.	Scotch Hill	Durick-Keenan & Co. (Inc.).
Do	Roofing	South Poultney	Fraser Slate Co.
Do	do	Wells	R. J. Williams Slate Co.; Joseph Pafundi.
Purple vein	do	Poultney	The Auld & Conger Co.
Unfading purple	Roofing and electrical	Fair Haven	Old English Slate Co.
Mottled purple	Mill stock	do	Owen O. Jones.
Do	Mill stock and roofing	North Poultney	Eureka Slate Quarries; Mahar Bros. Slate Co.
Do	Roofing	Poultney	New York Consolidated Slate Co.; H. & H. Slate Co.
Green	Roofing, electrical, and structural.	Fair Haven	D. C. Sherman Slate Co.; Hampshire Slate Co.; Old English Slate Co.; W. H. Pelkey.
Do	Structural	Hydeville	Minogue Bros. & Quinn.
Do	Roofing and mill stock	North Poultney	Eureka Slate Quarries; Mahar Bros. Slate Co.
Do	Roofing	Pawlet	O'Brien Bros.; F. C. Sheldon Slate Co.

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Color, use, and producers of slate in Rutland County, Vt.—Continued.

Color or shade.	Use.	Location of quarry.	Trade name of producer.
Green	Roofing	Poultney	Estate of William Griffith; E. J. Johnson Quarrying Co.; New York Consolidated Slate Co.
Do	do	South Poultney	Fraser Slate Co.
Do	do	Wells	Hayes-O'Brien Slate Co.; The Brownson Slate Co.
Sea-green	do	Pawlet and Wells	Norton Bros.
Do	do	Pawlet	Owen W. Owen's Sons (Inc.).
Do	do	Pawlet and Poultney	Rising & Nelson Slate Co.
Do	do	Poultney	The Auld & Conger Co.; H. & H. Slate Co.; Roberts & Carter.
Do	do	South Poultney	Edwards Bros.
Do	do	Wells	Joseph Pafundi; Roberts Slate Co.; R. J. Williams Slate Quarry Co.; Williams Bros.
Do	do	West Pawlet	S. F. Culbertson; Layden & Burdick; Progressive Slate Co.; Griffith T. Roberts.
Unfading green	Mill stock and roofing	Fair Haven	Fair Haven Marble & Marbleized Slate Co.
Do	do	North Poultney	Eureka Slate Quarries; W. H. Lloyd (Peerless Quarries).
Do	Roofing	Poultney	Eastern Slate Co.; Green Mountain Slate Co.
Mottled	do	Fair Haven	Hampshire Slate Co.; D. C. Sherman Slate Co.
Do	Mill stock	Hydeville	Minogue Bros. & Quinn.
Variegated	do	Fair Haven	Jones & Francis.
Do	Electrical and mill stock	Hydeville	P. F. Hinchey & Co.
Black	Roofing	Northfield	Northfield Slate Co.
Gray	do	Fair Haven	Hampshire Slate Co.
	Slate gravel used in the manufacture of felt roofing.	Castleton	Staso Milling Co.

VIRGINIA.

The value of the slate sold in Virginia in 1915 increased 3 per cent. The entire output was, as usual, roofing slate. The names and location of active companies and the colors of slate reported by them are as follows:

Color, use, and producers of slate in Virginia.

County.	Color or shade.	Use.	Location of quarry.	Trade name of producer.
Albemarle	Blue	Roofing	Esmont	Standard Slate Corporation.
	Variegated	do	do	Do.
Buckingham	Blue gray	do	Arvonia	Do.
	do	do	New Canton	The Buckingham Slate Products Corporation.
	Blue	do	Arvonia	The Williams Slate Co.
	do	do	Ore Bank	The LeSuer Slate Co.
	Blue black	do	Arvonia	Richmond Slate Co.
	Dark	do	do	A. L. Pitts Slate Co.
Fluvanna	Light gray	do	Strathmore	Dale Slate Co. (Inc.).

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PUBLICATIONS ON SLATE.

In 1915 there appeared in "Stone" a series of articles by Grasty on the uses of slate, the equipment of slate quarries, the failure of slate enterprises, and the examination of occurrences of slate.[1] "The Quarry" contained an article by Berlin on the advantages of electric power for the operation of pumps, air compressors, and hoists, and for general quarry operations.[2] These articles deserve the attention of all those interested in the improvement of the slate industry.

The following United States Geological Survey publications on slate are still available for distribution:

DALE, T. N., and others, Slate deposits and slate industry of the United States: U. S. Geol. Survey Bull. 586, 1914. A revised edition of Bull. 275.

MINERAL RESOURCES OF THE UNITED STATES. Separate chapters on slate for the years 1909–1914, inclusive, by A. T. Coons, contain, in addition to statistical data, the following information:

1909. Short review of the problem of slate waste.
1910. Slate for other uses than roofing and common mill slate.
1911. Manufacture of roofing slates; color of slate.
1912. Causes of slow development of slate industry; slate quarries and slate quarrying; machinery.

Special report on the commercial qualities of the slates of the United States and their localities, by T. Nelson Dale, with map showing productive and prospective slate deposits.

The State geological surveys of Arkansas, California, Maryland, and New Jersey have published descriptions of the slate and the slate deposits of these States, and information as to these publications may be had by applying to the respective State geologists.

A publication by E. C. Eckel[3] contains a chapter on slate, which gives information on the slates of the United States and of foreign countries and also many analyses and tests of slate.

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[1] Grasty, J. S., Stone, vol. 36, No. 1, pp. 30–31; No. 2, pp. 82–85; No. 3, pp. 138–139; No. 4, pp. 199–201, 1915.
[2] Berlin, R. C., Electricity in slate quarrying: The Quarry, vol. 20, pp. 248–252, October, 1915.
[3] Eckel, E. C., Building stones and clays, their origin, character, and examination, John Wiley & Sons, New York, 1912.

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FLUORSPAR AND CRYOLITE.

By Ernest F. Burchard.[1]

FLUORSPAR.

DOMESTIC OUTPUT.

The total quantity of domestic fluorspar reported to the Survey as sold in 1915 was 136,941 short tons, valued at $764,475, an increase in quantity of 41,825 short tons and in value of $194,434, representing nearly 44 per cent of the quantity and about 34 per cent of the value of the product marketed in 1914. The average price per ton for the whole country, all grades of fluorspar, gravel, lump, and ground considered, was approximately $5.58 in 1915, compared with $5.99 in 1914, a decrease of nearly 7 per cent. This value represents the selling price on board cars or barges at railroad or water shipping points; and with reference to the product from Colorado, New Mexico, and New Hampshire the price reported for much of the spar includes the cost of a long wagon haul—$1.50 to $3 a ton. In Illinois the principal producing mines are near river transportation and many of the mines reporting from Kentucky are near a railroad, so that the cost of long wagon hauls has not entered to an important extent into the reported value of the fluorspar from those States.

The year 1915 was a record year in the fluorspar industry in the United States, the output exceeding that of the next highest year, 1912, by more than 20,000 tons, or nearly 18 per cent.

As usual, the bulk of the fluorspar produced was sold as gravel spar, the quantity in 1915 amounting to 114,151 short tons, or 83 per cent of the total. With the exception of the years 1911 and 1912, in which the quantity of ground spar sold slightly exceeded that for 1915, all three grades of spar, gravel, lump, and ground, showed important increase in 1915 over all preceding years, the increase over 1914 being approximately 44 per cent, 36 per cent, and 54 per cent, respectively. The general average price of domestic fluorspar has declined steadily in the last four years largely as a result of improvements in methods of milling and handling large quantities of spar in the Illinois-Kentucky district, and this price was lower in 1915 than at any time in the last 10 years. The average price of all grades of spar decreased in 1915, the lump and ground 94 cents and 98 cents per ton respectively, but the gravel spar only 32 cents. In view of the increase in price of many mineral products during 1915 the decline in price of fluorspar is noteworthy. The demand for spar was unusually good and the competition from foreign spar very light, so that conditions were favorable for high prices. Some spar was undoubtedly sold long in advance at

[1] The statistics in this chapter were prepared by Miss L. M. Jones.

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low contract prices, but it is also probable that the large producers, who were in a position to do so, voluntarily kept the price of fluorspar down to a small margin of profit in order to win and hold for domestic spar the eastern markets, which had formerly been supplied largely by imported spar. The price in 1915 was so low, however, that some increase may be expected in 1916.

Sales of fluorspar were reported from five States in 1915—Illinois, Kentucky, New Hampshire, New Mexico, and Colorado, in the order named. All these States showed increase in sales in 1915, except Colorado, where there was a large proportionate decrease as compared with 1914. New Mexico reported no sales of spar in 1914 and that sold in 1915 was from stock, none having been mined in that year. The Kentucky figures barely exceeded those for 1914; the Illinois spar sold showed a greater increase than the net increase for the whole United States.

In Illinois the output in 1915 came from 2 mines, in Hardin County; in Kentucky 10 mines shipped spar—9 in Crittenden County and 1 in Livingston County; and 1 mine in New Hampshire, 1 in Colorado, and 1 in New Mexico shipped fluorspar during the year.

The total quantity of fluorspar reported to the Survey as mined in the United States in 1915 was 136,277 short tons, compared with 90,412 short tons mined in 1914, an increase of nearly 51 per cent.

The total stocks of fluorspar reported at mines or at shipping points December 31, 1915, were 8,497 short tons, compared with 9,176 short tons on hand at the close of 1914, according to revised reports. The stocks in 1915 consisted of 5,093 short tons of gravel spar, 2,306 tons of lump spar, and 1,098 tons of ground spar. Stock on hand is for the most part only roughly estimated by producers, therefore these figures can be regarded as only approximate; it is found, however, that the stocks on hand at the close of one year, together with the quantity mined during the following year, less the sales during that year, usually check closely with the stocks reported on hand at the close of the second year.

Such details of the fluorspar sales as may be published by the Survey without revealing statistics of individual producers are given in the following table for the years 1913, 1914, and 1915. Of these years the last two were "war" years, 1914 showing decidedly subnormal conditions and 1915 possibly abnormal conditions. The outlook for 1916, however, indicates a larger production and higher prices than in 1915.

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Domestic fluorspar sold, 1913–1915.

State.	Gravel.			Lump.			Ground.			Total.		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
1913.												
Illinois	91,663	$525,456	$5.73	5,676	$39,059	$6.88	8,137	$100,203	$12.31	85,354	$550,815	$6.42
Kentucky										19,422	113,903	5.80
Other States [a]	[b] 10,104	71,568	7.08	(b)	(b)	.....	.....	.....	.....	10,104	71,568	7.08
	[b] 101,767	597,024	5.87	[b] 5,676	39,059	6.88	8,137	100,203	12.31	115,580	736,286	6.37
1914.												
Illinois	77,048	397,913	5.16	8,842	74,708	8.45	6,998	82,428	11.78	73,811	426,063	5.77
Kentucky										19,077	128,986	6.76
Other States [a]	[b] 2,228	14,992	6.73	(b)	(b)	.....	.....	.....	.....	2,228	14,992	6.73
	[b] 79,276	412,905	5.21	[b] 8,842	74,708	8.45	6,998	82,428	11.78	95,116	570,041	5.99
1915.												
Illinois	112,769	547,415	4.85	12,033	90,337	7.51	10,757	116,161	10.80	135,559	753,913	5.56
Kentucky												
Other States [a]	[b] 1,382	10,562	7.64	(b)	(b)	.....	.....	.....	.....	1,382	10,562	7.64
	[b] 114,151	557,977	4.89	[b] 12,033	90,337	7.51	10,757	116,161	10.80	136,941	764,475	5.58

[a] Includes, 1913: Arizona, Colorado, New Hampshire, and New Mexico; 1914: Colorado and New Hampshire; 1915: Colorado, New Hampshire, and New Mexico.
[b] Some lump spar is included with gravel.

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In the following table summarizing the annual output of domestic fluorspar from 1883 to 1915, the quantities from 1883 to 1905 represent quantity mined; beginning with 1906 they represent quantity sold.

Fluorspar output in the United States, 1883–1915.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1883	4,000	$20,000	1895	4,000	$24,000	1907	49,486	$287,342
1884	4,000	20,000	1896	6,500	52,000	1908	38,785	225,998
1885	5,000	22,500	1897	5,062	37,159	1909	50,742	291,747
1886	5,000	22,000	1898	7,675	63,050	1910	69,427	430,196
1887	5,000	20,000	1899	15,900	96,650	1911	87,048	611,447
1888	6,000	30,000	1900	18,450	94,500	1912	116,545	769,163
1889	9,500	45,835	1901	19,586	113,803	1913	115,580	736,286
1890	8,250	55,328	1902	48,018	271,832	1914	95,116	570,041
1891	10,044	78,330	1903	42,523	213,617	1915	136,941	764,475
1892	12,250	89,000	1904	36,452	234,755			
1893	12,400	84,000	1905	57,385	362,488		1,150,961	7,027,067
1894	7,500	47,500	1906	40,796	244,025			

Figure 6 shows graphically the course of the production of fluorspar in the United States from 1883 to 1915. Two periods of fluctuation in output—between 1889 and 1898 and between 1902 and 1908—are in strong contrast with the large and steady increase in production in the periods 1898 to 1902 and 1908 to 1912. The decline from 1912 to 1914, although the greatest in actual tons, is not as great in proportion to the current production as that from 1905 to 1906, and the increase from 1914 to 1915 is clearly the largest in any single year. For convenience of comparison the imports, beginning with the first full year for which records are available, 1910, are shown on the same diagram.

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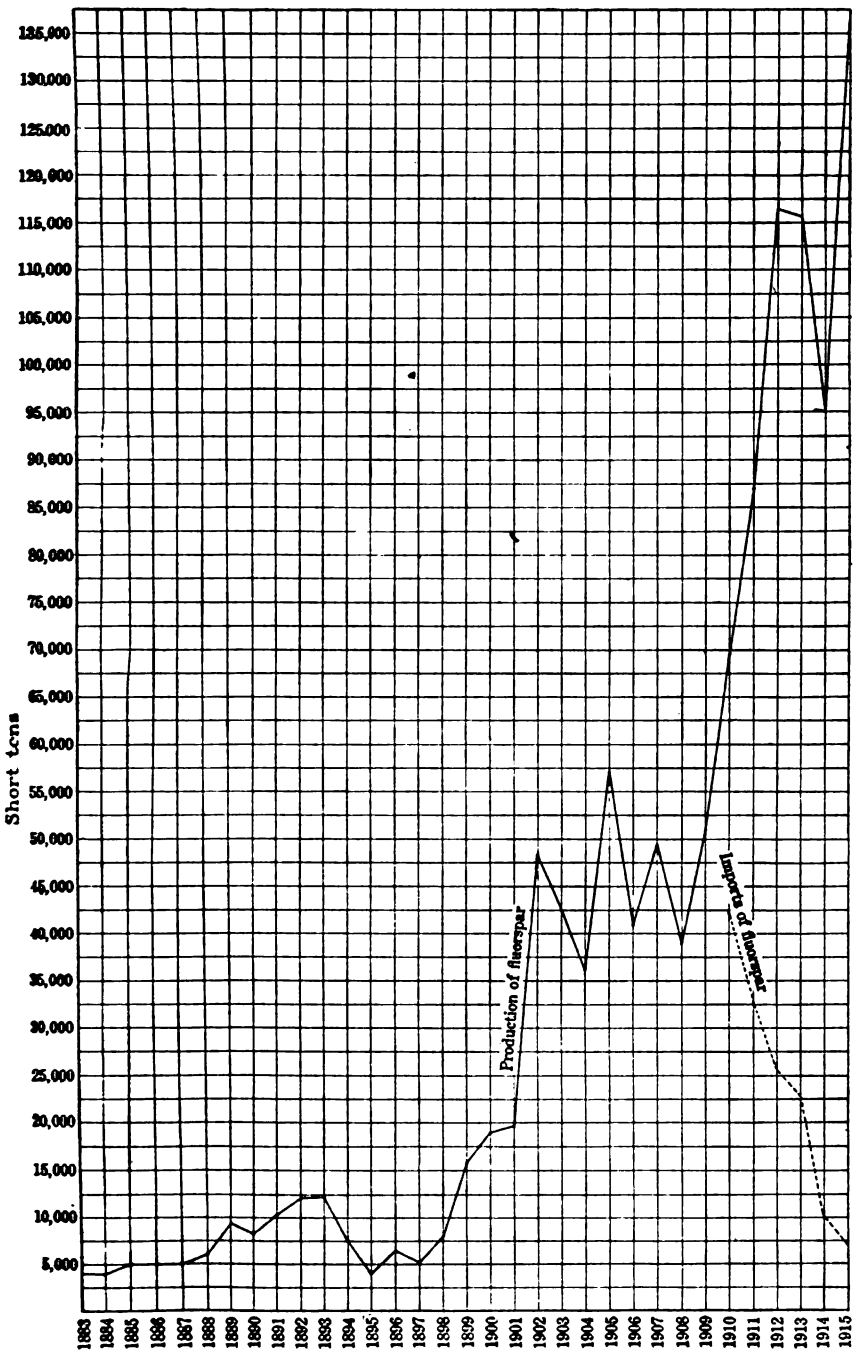

FIGURE 6.—Production of fluorspar in the United States, 1883–1915, and imports, 1910–1915.

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IMPORTS.

The imports of fluorspar into the United States entered for consumption in 1915 were 7,167 short tons, valued at $22,878, as compared with 10,205 short tons, valued at $38,943, in 1914. This represents a decrease of nearly 30 per cent in quantity and of about 41 per cent in value. The price assigned to the imports in 1915 averaged $3.19 a ton, as compared with $3.82 a ton in 1914, a decrease of 63 cents a ton, or about 16.5 per cent. The imports of fluorspar in 1915 were equivalent to about 6.3 per cent of the domestic production of gravel spar, as compared with nearly 13 per cent in 1914. The large falling off in the imports may be attributed to the interruption to commerce caused by the war in Europe as well as to depression in the mining industry in Great Britain due to scarcity of available operatives. The average reported price of imported spar at dock, exclusive of the duty, was equivalent to about 65 per cent of the average price of domestic gravel spar at mines or nearest shipping points in 1915, compared with 73 per cent in 1914. According to the prices reported, including the duty of $1.50 a ton but excluding freight charges, the average cost of imported spar to the consumer was $4.69 a ton in 1915, compared with $4.89 for domestic gravel spar at the mines or mills; in 1914 the cost of the imported material, including the duty of $1.50 a ton, was $5.32, compared with $5.21 for domestic gravel spar. The freight charges on domestic spar to points where it is consumed are generally higher than on foreign spar from the docks to eastern steel plants, so that a slight advantage in price is still enjoyed by the imported spar at eastern steel plants. Foreign spar is, however, not of so high grade as the mechanically treated spar from Illinois and Kentucky, and since fluorspar is of value chiefly according to its purity, purchasers find that the purer American spar is more efficient and consequently cheaper in the end.

Fluorspar imported and entered for consumption, 1909–1915.[a]

	Quantity (short tons).	Value.	Average price per ton.
1909	6,971	$26,377	$3.78
1910	42,488	135,152	3.18
1911	32,764	80,592	2.46
1912	26,176	71,616	2.74
1913	22,682	71,463	3.15
1914	10,205	38,943	3.82
1915	7,167	22,878	3.19

[a] Statistics compiled from records of Bureau of Foreign and Domestic Commerce, Department of Commerce.

CONSUMPTION OF FLUORSPAR.

The market for the bulk of the fluorspar sold in the United States depends on the steel industry, and the demand for fluorspar fluctuates with the rise and fall in the production of steel. Gravel spar is consumed as a flux in basic open-hearth steel furnaces and to a smaller extent in other metallurgical operations. In both 1914 and 1915 the sales of gravel spar constituted between 83 and 84 per cent of the total marketed output of domestic fluorspar. Fluorspar is used

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also as a flux in blast furnaces, iron foundries, and in silver, copper, and lead smelters; in the manufacture of fluorides of iron and manganese for steel fluxing; in the manufacture of glass, enameled, and sanitary ware, and of hydrofluoric acid; in the electrolytic refining of antimony and lead; and in the production of aluminum. In the last process fluorspar is reported to be fused with bauxite and soda ash into a so-called artificial cryolite, to which more bauxite is added, and from this mixture aluminum is extracted in the electric furnace.

A close estimate of the annual consumption of fluorspar in the United States can not be made without a knowledge of the stocks maintained by the consumers. These stocks are probably variable, but, as the value of fluorspar as a flux in the manufacture of open-hearth steel and in other metallurgical operations has become generally appreciated, consumers are taking care to keep stocks in reserve. However, the sales of domestic spar plus the imports (there are no considerable exports at present, and the figures are not listed separately by the Bureau of Foreign and Domestic Commerce) should give from year to year an index to the quantity entering into consumption and should indicate the relative increase or decrease in consumption. The apparent consumption of spar in 1915 was 144,108 short tons, as compared with 105,321 short tons in 1914, an increase of nearly 37 per cent.

The general relation between the consumption of fluorspar and the output of open-hearth steel may be noted by comparison of the following two tables:

Apparent consumption of fluorspar, 1910–1915, in short tons.

	Sales of domestic spar.	Imports for consumption.	Apparent consumption.
1910	60,427	42,488	111,915
1911	87,048	32,764	119,812
1912	116,545	26,176	142,721
1913	115,580	22,682	138,262
1914	95,116	10,205	105,321
1915	136,941	7,167	144,108

Open-hearth steel produced in 1910–1915, in long tons.[a]

	Basic.	Acid.	Total.
1910	15,292,329	1,212,180	16,504,509
1911	14,685,932	912,718	15,598,650
1912	19,641,502	1,139,221	20,780,723
1913	20,344,626	1,255,305	21,599,931
1914	16,271,129	903,555	17,174,084
1915	22,308,725	1,370,377	23,679,102

[a] Statistics for 1910 and 1911 according to annual reports of the American Iron and Steel Association and since 1911 from report of American Iron and Steel Institute.

FLUORSPAR IN GREAT BRITAIN.

According to the official report of output of mines and quarries issued by the Home Office at London, there were produced in Great Britain in 1914, the latest year for which statistics are available, 33,816 long tons of fluorspar, valued at $53,556, or $1.58 a ton, compared with 53,663 long tons, valued at $72,779, or $1.36 a ton, in 1913.

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Of the 1913 output, 11,433 tons were produced from mines in Derbyshire, probably including large quantities produced from mine dumps, and 19,830 tons from quarries in the same county, and 22,400 tons were produced from mines and mine dumps in Durham. The statistics for 1914 are not given in the same detail as those for 1913. When the output of fluorspar in England in 1911 to 1914 is compared with the imports of fluorspar into the United States in those years and when it is considered that the imports are derived almost wholly from England, it appears that a steadily decreasing proportion of the production of England is being shipped to the United States. The percentage in 1914 was about 27, as compared with about 37 per cent in 1913, 49 per cent in 1912, and 53 per cent in 1911.

CRYOLITE.

PRODUCTION.

No cryolite is produced in the United States, the entire supply used in this country being imported from Greenland.

IMPORTS AND PRICES.

The quantity of cryolite reported to have been imported for consumption in the United States in 1915 was 3,940 long tons, valued at $82,750, as compared with 4,612 long tons, valued at $94,424, in 1914. The average price per ton declared in 1915 was apparently $21, as compared with $20.47 in 1914. Cryolite is now imported free of duty.

CHARACTER.

Cryolite is a double salt of sodium fluoride and aluminum fluoride ($3NaF.AlF_3$). It crystallizes in the monoclinic system and has a hardness but little greater than that of gypsum, namely, 2.5. It is found associated with other minerals such as siderite, sphalerite, galena, chalcopyrite, and quartz. The color of cryolite is generally pure white, but in places smoke-colored pieces are found which contain well-developed crystals of red fluorspar.

SOURCE.

Cryolite has been found in commercial quantities only at Ivigtut, an Eskimo hamlet on the southern coast of Greenland in latitude 61° N. Minerals containing cryolite have been found near Pikes Peak, Colo., but not in paying quantities. The cryolite deposit at Ivigtut is reported to be a solid mass having surface dimensions of about 200 feet by 600 feet, and it has been worked as an open cut to a depth of about 150 feet. The deposit widens with depth, and the depth is unknown. It is quarried [1] by the Kryolith-Mine og Handelsselskab (the Cryolite Mining & Trading Co. (Ltd.)) under a State concession. In close connection with this company is the factory Oresund in Copenhagen, which has been given the technical use of this valuable mineral. During the two years 1913 and 1914 5,000 to 6,000 cubic meters (6,500 to 7,800 cubic yards) of cryolite were quarried. The exports of cleaned cryolite in 1913 were valued at $700,000. There is also a considerable direct export trade to America which does not come under Danish trade statistics.

[1] Winslow, E. D., consul general, Copenhagen, Denmark, Consular Report, Apr. 9, 1915.

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USES.

Formerly cryolite was used to produce sodium salts and alum, but other and cheaper sources of these materials are said to have displaced cryolite from this particular field. The more important uses at present for cryolite are in the manufacture of opaque white glass (sometimes called hot-cast porcelain) for the enameling of iron ware, in the metallurgy of aluminum, and as a flux in the manufacture of white Portland cement.

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FELDSPAR.

By FRANK J. KATZ.

INTRODUCTION.

The feldspar quarries in the United States are restricted to the eastern seaboard States and California. Important factors in the localization of feldspar mining in the New England, Middle Atlantic, and southern Appalachian States are the local abundance of feldspar deposits and the concentration of the ceramic industries about Trenton, N. J., and East Liverpool, Ohio. Potteries in California account for the exploitation of feldspar deposits in that State.

COMPOSITION AND PROPERTIES OF FELDSPAR.

Common feldspars are crystalline compounds of silica, alumina, and one or more of the bases, potash, soda, and lime. There are two principal classes of feldspar—the one including the potash and potash-soda varieties; the other including the soda, soda-lime, and lime varieties. Pure potash feldspars are orthoclase and microcline. These varieties are alike in chemical composition ($KAl.Si_3O_8$, or $K_2O.Al_2O_3.6SiO_2$) and alike in physical properties in so far as their industrially valuable qualities are concerned and therefore they are, commercially considered, identical. The theoretical composition of pure orthoclase or microcline is silica 64.7 per cent, alumina 18.4 per cent, potash 16.9 per cent; of pure soda feldspar, albite ($NaAl.Si_3O_8$, or $Na_2O.Al_2O_3.6SiO_2$), silica 68.7 per cent, alumina 19.5 per cent, soda 11.8 per cent. Potash feldspars commonly contain some soda replacing the potash. This may be more than equal to the potash in quantity, in which case the feldspar is called anorthoclase. Soda feldspars of the soda-lime group generally contain lime either by replacement of the soda or by admixture or intergrowth with lime feldspars. Two or more of the various feldspars may be present in the same deposit or in the same crystal.

Only the lime free or nearly lime free feldspars have any commercial importance. The feldspar mined in the United States is of the potash or soda variety or a mixture of the two. Most commonly the feldspar is dominantly potassic, but in one locality soda feldspars are mined and marketed. Commercial potash feldspars rarely contain more than 13 per cent K_2O, and the quarry or "run of mine" product generally contains an admixture of other minerals, which reduces the potash content to 10 per cent or less. Generally, also, the soda content of commercially so-called "potash spars" ranges from a fraction of 1 per cent to several per cent.

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The usefulness of the potash and potash-soda feldspars arises from the fact that within certain limited ranges of temperature they melt without becoming really fluid and that on cooling from the melt they form strong, colorless or light-colored glass. Soda-lime feldspars, on the other hand, are not useful, because the melted product after cooling is more or less crystalline. Potash feldspar begins to soften at about 1,150° C., or at Seger cone 1, and is completely fused at 1,310° C., Seger cone 9. For soda feldspar the corresponding range is about 150 C., but complete fusion takes place at a somewhat lower temperature.[1]

Feldspars have a highly developed capacity to cleave on plane surfaces in two directions inclined at 90° or nearly 90°, and an imperfect cleavage in a third direction. This facilitates crushing and grinding and makes for easy reduction to sharp particles. The hardness of feldspar is about that of ordinary glass and, therefore, the mineral is more suitable for certain abrasive cleansers and polishers than harder substances commonly used.

The potash and potash-soda feldspars mined in the United States are mostly pale flesh-colored to nearly white. Some are reddish and pearly gray. Soda feldspars and soda-lime feldspars are commonly pure white or light gray and pale green in color. When finely ground all commercial feldspars are either white or show very pale pink or salmon-colored tints.

GEOLOGY AND MINERALOGY OF FELDSPAR DEPOSITS.

The feldspars are among the most widely distributed minerals and occur as constituents of nearly all igneous rocks. In most rocks, however, the feldspar is in too small grains and is too intimately associated with other minerals to be of commercial importance. Commercially valuable feldspar usually occurs as a constituent of pegmatites—rocks of extremely coarse grain and irregular texture. In mineral composition pegmatites may vary greatly, but those of present commercial importance belong chiefly to two types: (1) The granite pegmatites, which are essentially giant granites, their minerals being chiefly feldspar, quartz, and mica, the same as those most abundant in ordinary granites, and (2) the soda pegmatites, which contain no quartz and little or no mica, but consist mainly of soda feldspar (albite) and small quantities of hornblende. By far the larger number of the feldspar quarries of the United States are in deposits of granite pegmatite; only a few, in southeastern Pennsylvania and adjacent parts of Maryland, belong to the soda pegmatites.

The pegmatites which are exploited for feldspar have been forced into the inclosing rocks in a highly fluid state and solidified under conditions which favor coarse crystallization and the development of irregular textures—the characteristics of pegmatites.

In size the pegmatite masses range from bands a few inches across to great masses half a mile in width and traceable in places for miles. The form of some of these masses is very irregular, but most of them are more or less lens-shaped and are intruded

[1] Day, A. L., and Allen, E. T., The isomorphism and thermal properties of the feldspars: Carnegie Inst. Washington Pub. 31, 1905, pp. 13–75; also Am. Jour. Sci., 4th ser., vol. 19, pp. 93–142, 1905.

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along the planes of easiest parting in the surrounding rocks. Because of the tendency of pegmatite to follow the planes of easiest parting in the bordering rocks, it is possible in some areas to predict its occurrence beyond the visible outcrops; but all such predictions must be made with reservation, as the pegmatite is liable to pinch out or to cut irregularly across the trend of the inclosing rocks. Pegmatite bodies in massive rocks, such as granite, may be very irregular; but they usually follow more or less parallel walled fractures in the rock.

The granite pegmatites contain, besides feldspar, the following minerals in abundant proportions: Quartz, muscovite or white mica, biotite or black mica, and black tourmaline. Generally less abundant are garnet, magnetite, and beryl. Quartz, if present in quantity less than 20 per cent, and white mica, if present in small quantities, only, are not harmful in feldspar required for the manufacture of pottery. The colored minerals, such as black mica, tourmaline, garnet, magnetite, and, to a less extent, beryl, are to be avoided in quarrying feldspar for pottery. If in small quantities, none of the associated minerals seriously affect the quality of feldspar for use in the manufacture of fertilizer material. In most pegmatites there is an intimate intergrowth of quartz with some of the feldspar. This intergrowth is not deleterious if the quartz content does not exceed 20 to 30 per cent and if a sufficient quantity of pure feldspar is added to reduce the total percentage of quartz in the ground product to between 15 and 20 per cent.

COMMERCIAL AVAILABILITY.

Whether it will pay to work a given feldspar deposit depends on a number of factors, chief among which are (1) the distance from railroad or navigable water; (2) the freight rates to principal markets; (3) the quantity and quality of the material available; (4) the cheapness with which the feldspar can be mined; and (5) the market conditions. Favorable conditions with respect to some of these factors may offset unfavorable conditions with respect to others. The principal markets for the better grades of feldspar are the great pottery centers—Trenton, N. J., and East Liverpool, Ohio—so that the mines of Connecticut, Pennsylvania, and Maryland have the advantage over those in Maine and northern New York of being much closer to these markets. This superiority in position makes wagon hauls from mine to shipping point of 6 or 8 miles permissible in these Middle Atlantic States, whereas in Maine or in the Adirondack region a deposit must be much closer to the shipping point to be worked with a fair degree of profit. Pegmatite sold for roofing or poultry grit commands prices so small that hauls of more than 1 or 2 miles from mine to shipping point would in most places be prohibitive.

The requirements of the potter's trade demand that in general the percentage of free quartz associated with the feldspar used for this purpose shall not exceed 20 per cent in the ground product, and certain potters demand a spar which is nearly pure, containing probably less than 5 per cent of free quartz. In order to be profitably worked, in most feldspar mines between one-fourth and one-half of the total material that must be excavated should contain less than 20 per cent

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of free quartz. Freshness of the feldspar, though desirable, is not essential.

A factor of the utmost importance in the mining of pottery spar is the quantity of iron-bearing minerals (black mica, hornblende, garnet, black tourmaline, etc.) present and the manner in which these minerals are associated with the feldspar. The requirements of the pottery trade demand that the spar be nearly free from these minerals, which if present produce upon firing brown discolorations in white wares. In order that a deposit may be worked profitably these minerals, if present in any appreciable quantity, must be so segregated in certain portions of the deposit that they can be separated from the spar without much more hand sorting and cobbing than is necessary anyway in the separation of the highly feldspathic material from that which is highly quartzose or rich in muscovite. Many pegmatite deposits of coarse grain are rendered worthless for use in pottery by the abundance of one or more of these iron-bearing minerals. The presence here and there of minute flakes of white mica (muscovite) is characteristic even of the highest grades of commercial feldspar, and chemically this mineral is not injurious. It is, however, exceedingly difficult to pulverize the thin, flexible mica plates to a finenes equal to that required in the feldspar, and it is therefore necessary in mining to separate carefully as much of the muscovite as possible from the spar.

Recently potash feldspars have been sought as a source of potash salts and also by reason of their potash content for incorporation in so-called complete fertilizers. For such purposes the prices paid are generally less than for pottery feldspar of first and second grade, and if such use of feldspar is found practicable the quantities required will be far in excess of those heretofore annually required by the pottery industries. To supply such a demand pegmatite deposits must be of large size and very favorably located with respect to transportation facilities and market.

The requirements for extraction of potash and for use in fertilizer are a high potash content and convenience of location. The presence of quartz and of iron-bearing and other minerals is of no significance if they are not in quantities so large as to reduce materially the content of potash. Both white and black mica are potash-bearing minerals and therefore not wholly undesirable.

Almost any coarse, undecomposed granite pegmatite is adapted to the manufacture of roofing materials and poultry grit.

Operation on a large scale with the aid of modern machinery reduces the mining cost. Favorable topographic position—a situation, for instance, that will permit the material to be excavated from a hillside instead of being hoisted from a pit—also reduces the cost of mining.

METHODS OF MINING.

The methods of mining feldspar are very simple. The excavations are nearly all open pits, most of them of rather irregular form, the valueless portions of the pegmatite being avoided wherever possible. In quarries where the pegmatite masses are rather flat lying and are overlain by a roof or worthless rock, short tunnels have been driven from the open pits.

In the Northeastern States the pegmatite is usually firm and undecomposed, even in the surface outcrops, and it is necessary to sink

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drill holes and blast out most of the material. In Pennsylvania, Maryland, and farther south, most of the pegmatite is much decayed at the surface, and in the upper part of the deposits it can be readily excavated with picks, shovels, and crowbars.

The material used for making pottery is hand picked at the quarries to remove the more micaceous and quartzose parts and those carrying colored minerals.

METHODS OF MILLING.

The methods used for grinding feldspar for pottery and enamel ware are similar in a general way in all the Eastern States. Some spar is first burned in kilns, which serves to fracture it and thus facilitate grinding. Most feldspar, however, is fed just as it comes from the quarry into chaser mills. The material from the chasers is screened, the tailings being returned for recrushing and the fines going to the tube mills for fine grinding. For use in pottery it is so ground, as screen tests on commercial pottery spar have shown, that 99.3 to 99.8 per cent passes through a 100-mesh screen and 96.7 to 98.2 per cent through a 200-mesh screen. Some feldspar prepared for use in abrasive soaps is even more thoroughly ground to reduce it to extreme and uniform fineness. For making glass and enameled ware, a tested sample of ground feldspar showed 94 per cent passing through a 100-mesh screen and 74 per cent through a 200-mesh screen. Mills for grinding feldspar for poultry grit and roofing employ jaw or rotary crushers and steel rolls; the crushed product is graded by screening.

USES.

The principal use of feldspar is in the manufacture of pottery, chinaware, porcelain, enamel ware, and enamel brick and tile. It is used in both the body and the glaze of the various grades of ceramic products. In the body it constitutes from 10 to 35 per cent, its value there being due to the fact that it melts during firing at a temperature below the fusing points of the other ingredients and forms a firm bond between the particles of clay and quartz. In glazes the percentage of feldspar used is higher than in the body and runs from 30 to 50 per cent. Other uses of feldspar, which do not require the high grade demanded by the pottery trade, are in the manufacture of emery and corundum wheels, where it serves as a binder; in the manufacture of opalescent glass; as a poultry grit; as a constituent of roofing material; and for surfacing concrete work. Small quantities of the purest grades of potash feldspar are used in the manufacture of artificial teeth. For this purpose it brings the highest prices—$6 to $8 a barrel of 350 pounds. It is also used in the manufacture of scouring soaps and window wash.

The use of ground feldspar as a fertilizer has been proposed, but the results of extensive tests by the United States Department of Agriculture prove that only under special conditions is such use of value. Attempts to extract from feldspar its content of potash are still in an experimental stage. A number of patents have been taken out on processes of extraction of potash from feldspar and other potash silicates. These are summarized in the report on potash salts. Other experiments are directed toward the treatment of feld-

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spar or other potash silicate rock in such a manner as to make its potash content readily soluble, and then to use the treated feldspar as a fertilizer or as an ingredient of complete fertilizers. It is reported that some of the larger manufacturers of fertilizer have so used feldspar during 1915; no definite information has been obtained from them.

FELDSPAR LOCALITIES IN THE UNITED STATES.

Maine.—Maine is one of the principal feldspar-producing States. Commercially valuable deposits of pegmatite in Maine abound in the south-central and southwestern part of the State. There are or have recently been productive quarries in the counties of Androscoggin, Cumberland, Lincoln, Oxford, and Sagadahoc.

New Hampshire.—Workable feldspar deposits in New Hampshire are located near Grafton Center, in Grafton County.

Vermont.—There are large deposits of high-grade feldspar in Vermont at Chester, Windsor County.

Massachusetts.—Feldspar pegmatite dikes are abundant throughout most of Massachusetts, but they have been commercially productive only near Blandford, Hampden County.

Connecticut.—Connecticut has for many years been an important feldspar-producing State. Pegmatites are abundant in parts of the Connecticut Valley and are worked in Hartford and Middlesex counties. Litchfield County and New Haven County are also feldspar producers.

New Jersey.—Pegmatites in New Jersey have not been commercially developed.

New York.—New York is an important feldspar-producing State. Pegmatite dikes are abundant in Westchester County and throughout the Adirondack region. Westchester County has long been a large producer of high-grade feldspar, and important deposits of excellent spar are worked in Fulton and Saratoga counties. Essex and Warren counties have important deposits of feldspar, and there are excellent prospects in remoter parts of Clinton, Franklin, and Morris counties.

Pennsylvania, Delaware, and Maryland.—A belt of territory extending from the vicinity of Chester southwest through Chester County, Pa., and through Harford, Baltimore, Howard, and Montgomery counties, Md., and including also a small area in northern Delaware, contains a great number of large, high-grade pegmatite dikes, which are quarried in many places and which supply a large proportion of the feldspar consumed in the United States.

Virginia, North Carolina, South Carolina, Georgia, and Alabama.—The Piedmont province in these States and much of the Appalachian Mountain province are occupied by rocks in which pegmatite dikes are widely distributed. Some of these have been worked for feldspar and many more have been developed for their content of kaolin, mica, and gem minerals; these latter give promise of supplying feldspar also. In Virginia an area in Bedford and Henry counties and another in Amelia and Prince Edward counties have been commercial producers of feldspar. In North Carolina the Spruce Pine district in Avery, Mitchell, and Yancey counties annually produces a large quantity of feldspar. The regions of Iredell,

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Lincoln, and Cleveland, and of Jackson, Macon, and Swain counties are particularly promising for feldspar production. In South Carolina some feldspar has been produced in the neighborhood of Pacolet, in Spartanburg County. There has been no production of feldspar in Georgia or Alabama.

Wisconsin and Michigan.—In central northern Wisconsin and upper Michigan is an area which contains abundant pegmatite dikes, from which there has so far been no commercial production.

Minnesota.—Granitic rocks in which there are some pegmatites occupy the northern counties of Minnesota and are also found in the valleys of Red and Minnesota rivers. The feldspar pegmatites in these regions have not been investigated and the value of these regions as sources of feldspar is not known.

Missouri.—In St. Genevieve County in the Ozark regions of Missouri there are pegmatite dikes containing feldspars of good grade. There has been no commercial development in this region.

Texas.—In Llano and Burnet counties, Tex., there are pegmatite dikes which may become a source of feldspar.

South Dakota.—In the vincinity of Harney Peak, Custer County, in the Black Hills region of South Dakota, there are many pegmatite dikes. These have been mined for tin and lithium-bearing minerals and for mica but have not been worked as a source of feldspar.

Colorado.—The Rocky Mountain region of Colorado contains many pegmatite dikes which are undeveloped. Deposits in Eldorado and Freemont counties have been prospected and in Mesa County mica has been mined from a pegmatite which contains a large quantity of feldspar.

California.—Fresno, Tulare, and Monterey counties have supplied feldspar to California potteries, and small shipments have been made from Kern, Inyo, and Riverside counties. There are large areas of granitic and metamorphic rock in the Sierra Nevada Mountains and in the southern coast ranges of California which contain pegmatite dikes, but there is very little information concerning their commercial availability. Probably most of them are too remote from market for any present or early future developments.

Other Western States.—Pegmatites are reported in other Western States, but without data as to their character, size, and abundance. There are possibilities for feldspar development in various areas of granitic and metamorphic rocks, if ever local markets arise.

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MARKETED PRODUCTION.

The marketed production of feldspar in 1915 was nearly 16 per cent less in quantity than in 1914. On the other hand, the decrease in value was very slight because of a small increase in the price per ton of crude spar and a material increase in the price per ton of ground spar; also, because of a larger proportion of spar first marketed in ground form. The quantity and value for 1915 were also less than for 1913 but much greater than for former years.

The average price for spar sold crude in 1915 was $3.46 per long ton as compared with $3.43 in 1914 and $3.41 in 1913 (equivalent values per short ton, $3.12, $3.07, and $3.31). The average price in 1915 of ground spar was $8.33 per short ton as compared with $7.40 in 1914 and $8.31 in 1913. The average price per short ton for the entire production in 1915, that is, combined sales of both crude and ground spar was $5.54, as compared with $4.77 in 1914 and with $6.49 in 1913. Of the total marketed product of 1915 about 53.5 per cent was sold crude and 46.5 per cent was sold ground.

Apparently more than 95 per cent of the production in 1915 was consumed in the ceramic industries. An undetermined but small quantity was used in making glass. Probably less than 100 tons was sold as chicken grits and apparently less than 1,000 tons was used experimentally for extraction of potash or as an ingredient of fertilizers. Roofing and cement surfacing accounted for about 1 per cent of the total quantity and one-half of 1 per cent of the total value. About 2,000 tons, valued at approximately $15,000, went into abrasive materials.

The following tables present classified data of the production of feldspar in recent years. The unwillingness of one feldspar producer to make a detailed report of operations has made it impossible to classify the data for 1915 as fully and accurately as in previous years.

Feldspar sold in 1914 and 1915.

1914.

State.	Crude.		Ground.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
California	2,778	$10,715	.....	.....	2,778	$10,715
Connecticut	11,099	42,965	5,414	$40,326	16,513	83,291
Delaware	(a)	(a)	.....	.....	(a)	(a)
Maine	12,553	30,925	17,510	163,635	30,063	194,560
Maryland	5,867	19,224	42	210	5,909	19,434
New Hampshire	(a)	(a)	.....	.....	(a)	(a)
New York	289	1,032	19,290	100,995	19,579	102,027
North Carolina	15,420	43,153	.....	.....	15,420	43,153
Pennsylvania	2,843	10,162	7,258	61,231	10,101	71,393
Virginia	b 35,056	b 105,300	.....	.....	35,056	105,300
	85,905	263,476	49,514	366,397	135,419	629,873

a Included in Virginia.
b Virginia includes Delaware and New Hampshire.

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Feldspar sold in 1914 and 1915—Continued.

1915.

State.	Crude.		Ground.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
California	(a)	(a)	(a)	(a)	2,004	$9,550
Connecticut	(a)	(a)	(a)	(a)	13,510	73,124
Delaware						
Maine	(a)	(a)	(a)	(a)	27,878	191,456
Maryland	12,485	$36,861			12,485	36,861
New Hampshire	(b)	(b)			(b)	(b)
New York	(a)	(a)	(a)	(a)	17,375	65,988
North Carolina	(a)	(a)			c 24,687	c 131,393
Pennsylvania	(a)	(a)	(a)	(a)	15,830	120,964
Virginia	(b)	(b)			(b)	(b)
	60,811	188,443	52,958	$440,913	113,769	629,356

a Figures withheld to avoid disclosing individual production.
b New Hampshire and Virginia included in North Carolina.
c North Carolina includes Virginia and New Hampshire, and also a quantity of feldspar mined in North Carolina, but before being marketed, ground in Tennessee.

Feldspar sold in 1910–1915.

Years.	Crude.		Ground.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1910	24,665	$81,965	56,447	$420,487	81,102	$502,452
1911	28,131	88,394	64,569	490,614	92,700	579,008
1912	26,462	89,001	60,110	431,561	86,572	520,562
1913	45,391	148,549	75,564	628,002	120,955	776,551
1914	85,905	263,476	49,514	366,397	135,419	629,873
1915	60,811	188,443	52,958	440,913	113,769	629,356

FELDSPAR INDUSTRY BY STATES.

The sales of feldspar in 1915 were reported from the following States named in the order of their output: Maine, North Carolina, New York, Pennsylvania, Connecticut, Maryland, California, New Hampshire, and Virginia. Named in the order of value of their output they were Maine, Pennsylvania, Connecticut, New York, North Carolina, Maryland, California, New Hampshire, and Virginia.

California.—Four quarries, 2 in Tulare County, 1 in Monterey County, and 1 in Riverside County, reported production in 1915. This is one more than in 1914. The total production in 1915 was 2,004 short tons, valued at $9,550, a decrease of approximately 20 per cent in quantity and 11 per cent in value, as compared with 1914. Nearly all of the California output was used for pottery manufactured in the State; a small remainder was used in concrete facings.

Connecticut.—Connecticut ranked fifth in quantity and third in value as a feldspar producer in 1915. The production came principally from four large quarries or groups of quarries in Hartford and Middlesex counties; a small quantity was also collected by the larger operators from small independently operated quarries. The

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total output in 1915 was 13,510 short tons, valued at $73,124, a decrease of 18 per cent in quantity and 12 per cent in value, as compared with 1914. There was one feldspar mill in operation throughout the year. The product was used for pottery, enamel ware, tile, glass, and abrasive soaps.

Delaware.—No feldspar was produced from Delaware quarries in 1915. The feldspar mill at Wilmington was in operation during the year.

Maine.—Maine ranked first in quantity and value as a feldspar producer in 1915. Three companies operating 5 quarries in Androscoggin and Sagadahoc counties produced 27,878 short tons, valued at $191,456. Mills were operated at Auburn in Androscoggin County and at Topsham and Cathance in Sagadahoc County. As compared with 1914 there was a decrease of 7 per cent in quantity and nearly 2 per cent in value. Crude spar sold for $3 and $4 per long ton and ground spar for $8.50 and $10 per short ton.

Maryland.—Maryland was sixth in rank in quantity and value of its output of feldspar in 1915. The production came from 10 quarries and amounted to 12,485 short tons, valued at $36,861. This was an increase of about 100 per cent in quantity and 90 per cent in value, as compared with 1914. The average price for crude spar in Maryland was $3.30 per long ton and prices ranged from $1.75 to $3.68 per ton. There were no feldspar mills in operation in Maryland. The product is shipped to Wilmington, Del., Trenton, N. J., and Toughkenamon, Pa., for grinding and is almost entirely consumed in the manufacture of pottery; a small quantity is sold as chicken grits, for potash extraction, and for the manufacture of fertilizers.

New Hampshire.—Feldspar was produced by one company quarrying near Grafton Center, Grafton County, N. H.

New York.—New York ranked third in quantity and fourth in value of its output of feldspar in 1915. Four companies operated 5 quarries in Essex, Westchester, Franklin, and Saratoga counties. There were in operation during the year 2 mills in Essex County for the crushing and coarse grinding of feldspar, 1 in Westchester County for fine grinding, and 1 at Barnard, Monroe County, where feldspar imported from Canada was ground. The total production of the State for 1915 was 17,375 short tons, valued at $65,988. About 80 per cent of the product was used for roofing, concrete facings, chicken grits, etc., and the remainder for pottery, enamel ware, glass, and abrasive soaps.

North Carolina.—North Carolina ranked second in quantity and fifth in value as a producer of feldspar in 1915. Two companies operated in the Spruce Pine district, one of which shipped to Trenton, N. J., and East Liverpool, Ohio, the other shipped its product to its own mill at Erwin, Tenn.

New Jersey.—New Jersey is not a feldspar-producing State, but Trenton, N. J., is an important feldspar market in which are located feldspar grinding mills.

Pennsylvania.—Pennsylvania ranked fourth in quantity and second in value as a producer of feldspar in 1915. Spar was drawn from eight of the larger quarries and several unlisted small ones. The total output was 15,830 short tons, valued at $120,984. This

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was an increase of about 50 per cent in both quantity and value, as compared with 1914. The average price for crude spar in 1915 was about $2.50 per long ton and for ground feldspar was approximately $9 per short ton. Pennsylvania feldspar is used for pottery, tile, enamel ware, glass, poultry grits, roofing, and abrasive soaps.

Ohio.—Ohio is not a feldspar-producing State, but East Liverpool, Ohio, is an important feldspar market, in which are located feldspar grinding mills.

Virginia.—A small quantity of feldspar was produced in Amelia and Pittsylvania counties, Va. It is reported that preparations were under way for extensive operations to supply fertilizer manufacturers.

PRODUCTION IN OTHER COUNTRIES AND IMPORTS.

The following table gives such figures as are available on the production of feldspar in recent years in the United States and other countries. The United States imports nearly the whole of the Canadian production and none from other countries.

Feldspar sold in principal producing countries, 1911–1915.

Country.	1911		1912		1913	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
United States	92,700	$579,008	86,572	$520,562	120,955	$776,551
Belgium [a]	.....	1,655	.....	660	(b)	(b)
Canada [c]	17,723	51,939	13,733	30,916	15,935	56,841
Germany (Bavaria) [a]	3,480	13,689	7,348	49,581	(b)	(b)
Italy [d]	39,417	44,585	37,416	44,079	35,569	39,172
Madagascar [a]	.....	.....	451	.....	(b)	(b)
Norway [c] [e]	38,429	124,096	43,919	146,325	(b)	(b)
Sweden [a]	39,942	89,743	37,814	88,682	(b)	(b)

Country.	1914		1915	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
United States	135,419	$629,873	113,769	$629,356
Belgium [a]	(b)	(b)	(b)	(b)
Canada [c]	18,060	70,824	15,455	59,124
Germany (Bavaria) [a]	(b)	(b)	(b)	(b)
Italy [d]	35,863	43,305	(b)	(b)
Madagascar [a]	(b)	(b)	(b)	(b)
Norway [c] [e]	(b)	(b)	(b)	(b)
Sweden [a]	(b)	(b)	(b)	(b)

[a] Statistics taken from Mines and quarries: General report and statistics, part 4, London.
[b] Statistics not available.
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[d] Includes quartz; statistics taken from Rivista del Servizio minerario, Rome.
[e] Export figures.

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SILICA (QUARTZ).

By FRANK J. KATZ.

INTRODUCTION.

Silica, the oxide of silicon (SiO_2), which has been treated in these reports under the heading "Quartz" (including flint), is the most abundant of mineral substances. It occurs in deposits of commercial importance in many different forms; such as vein quartz, as a constituent of pegmatites, as sand, sandstone, quartzite, or flint, as tripoli, and as diatomaceous (infusorial) earth. In some forms, such as rose, smoky, and amethystine quartz, it has value as gems. This chapter deals with silica of all kinds except gem quartz, silica used for making glass, and silica used in the form of sand, gravel, and crushed material for building, for concrete and mortar, for foundry and furnace work, and for cutting and grinding stone. Such material as is not here included is either gem material or sand, is commercially so designated, and is therefore considered in other chapters of Mineral Resources. Tripoli and diatomaceous earth are to a large extent consumed as abrasives and are considered in the chapter on abrasive materials.

USES.

Silica (quartz) as discussed in this chapter is used for many purposes, principally in the manufacture of pottery, paints, and scouring soaps, as a wood filler, as a polisher, and in metallurgical and chemical processes. In the pottery industry, where it is generally called flint, silica is used in the body of the ware to diminish shrinkage and is also used in glazes. Silica for use in pottery should contain less than 0.5 per cent of iron-bearing minerals. Manufacturers of paint use considerable quantities of very finely ground silica, which forms as much as one-third of the total pigment in some paints. For this purpose finely ground crystalline material is superior to fine sand in its natural state because of the angularity of the grains, which makes them adhere more firmly to the article painted and after wear affords a good surface for repainting. The same angularity makes artificially comminuted crystalline quartz superior to natural sand for use in wood fillers. For soaps and polishing powders ground material is preferred to natural sand on account of its whiteness and angularity. For all these purposes large quantities of pure quartz sand and sandstone are finely ground and yield a product fully equal to that obtained by grinding massive crystalline quartz.

The material known commercially in the United States as tripoli, which is the siliceous residue of decomposed limestones, also yields

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an excellent grade of pulverized silica, which is used for the same purpose as silica powder obtained from massive crystalline quartz and from sands and sandstones. Diatomaceous (infusorial) earth is also used to make polishing powder that is employed for similar uses to those for which quartz, sand, and tripoli powders are employed, but diatomaceous earth has somewhat different properties and most of it finds different application.

Quartz crushed and graded to various sizes is used in making sandpaper and sand belts, as a scouring agent, for "frosting" glass with sand-blast apparatus, and for other purposes. Blocks of massive quartz and quartzite are used in the chemical industry as a filler for acid towers and as a flux in copper smelting. Ground quartz is also used in filters and in tooth powders and by dentists as a detergent.

Sand and crystalline quartz have been used in making silicon and alloys of silicon with iron, copper, and other metals in the electric furnace. Quartz may be fused in the electric furnace to make chemical apparatus, such as tubes, crucibles, and dishes.

PRODUCTION AND SALES.

The reports to the United States Geological Survey on the production and sales in 1915 of various forms of silica for the uses considered in this chapter were more satisfactory than those for 1914 and 1913. It is possible to summarize in the following tables, without claim of entire completeness or accuracy, the marketed production in 1915 of vein and pegmatite quartz and quartzite, of finely ground sand and sandstone, of tripoli, and of diatomaceous earth. (The statistics on diatomaceous earth do not include a large quantity produced in California and used for making filters and as insulating and fireproofing materials.) The records for 1915 for the combined output of these materials show an increase in quantity of 5 per cent over 1913 and 34 per cent over 1914, and corresponding increases in value of nearly 33 per cent and 106 per cent. Tripoli and diatomaceous earth are more fully considered in the chapter on abrasive materials; only the total quantity and value of their output are repeated here.

Silica sold for pottery, paints, fillers, polishers, abrasives, and other uses in 1913, 1914, and 1915.

Material.	1913		1914		1915	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Quartz (vein quartz, pegmatite, and quartzite)	97,902	$201,488	153,401	$360,502	112,575	$273,553
Sand and sandstone[a]	106,857	466,523	.....	.....	95,461	386,261
Tripoli	20,831	216,517	17,218	142,428	30,711	572,504
Diatomaceous earth	6,602	69,304	11,012	109,899	4,593	38,517
	232,192	953,832	181,731	612,829	243,340	1,270,835

[a] Includes only finely ground material. Figures probably incomplete.

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QUARTZ.

PRODUCTION.

Quartz from quartz veins, pegmatite, and quartzite, amounting to 112,575 short tons, valued at $273,553, was sold in 1915. This was a decrease of 27 per cent in quantity and of 24 per cent in value, as compared with 1914. The decrease was in both crude and ground materials, but greater for the latter.

The average price of crude quartz in 1915 (exclusive of large quantities for metallurgical purposes, which were valued at 50 to 85 cents per ton) was $3.30, as compared with $2.44 in 1914. Prices of ground quartz ranged from $6 to $20 per ton and averaged $10.56, as compared with $9.09 in 1914.

The statistics are classified in the following tables:

Vein and pegmatite quartz and quartzite sold in the United States, 1914–15, by States.

1914.

State.	Crude.		Ground.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Arizona, Michigan, South Dakota, and Wisconsin	5,163	$5,909	5,418	$46,687	10,581	$52,596
California	2,100	3,900	335	3,903	2,435	7,803
Maryland	4,046	8,229	8,011	59,405	12,057	67,634
Connecticut, Maine, Massachusetts, and Pennsylvania	4,249	12,160	7,335	124,380	11,584	136,540
North Carolina, Tennessee, and West Virginia	107,950	58,622	8,794	37,307	116,744	95,929
	123,508	88,820	29,893	271,682	153,401	360,502

1915.

Arizona, Michigan, and Wisconsin	4,280	$3,739	6,673	$55,388	10,953	$59,127
California	2,898	10,600	722	9,002	3,620	19,602
Connecticut, New York, Maine, and Massachusetts	2,140	6,895	4,437	86,430	6,577	93,325
Maryland	3,025	12,718	3,182	24,139	6,207	36,857
Pennsylvania, North Carolina, and Tennessee	81,956	46,678	3,262	17,964	85,218	64,642
	94,299	80,630	18,276	192,923	112,575	273,553

Quartz sold in the United States, 1910–1915.

Year.	Crude.		Ground.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1910	49,886	$80,984	13,691	$112,773	63,577	$193,757
1911	77,759	70,430	10,184	84,692	87,943	155,122
1912	82,205	67,256	15,669	124,429	97,874	191,685
1913	74,176	54,442	23,726	147,046	97,902	201,488
1914	123,508	88,820	29,893	271,682	153,401	360,502
1915	94,299	80,630	18,276	192,923	112,575	273,553

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Quartz or silica for the purposes here considered was produced in Arizona, California, Connecticut, Maine, Maryland, Massachusetts, New York, North Carolina, Pennsylvania, and Tennessee; and quartz sand and sandstone in Alabama, Colorado, Illinois, Maryland, Ohio, Pennsylvania, Virginia, and West Virginia.

QUARTZ INDUSTRY BY STATES.

Alabama.—In Alabama one firm made an initial production of sandstone near Trussville, Jefferson County, from property acquired late in the year and reported that a mill for grinding would be put into operation.

Arizona.—Only one firm reported production in Arizona in 1915. The material was quartzite used for reverberatory bottoms, and the production was larger than in 1914.

California.—Five operators reported quartz production in California in 1915; two of them operated grinding plants. The sources were vein quartz near Perris, Riverside County; quartz bowlders at Dutch Flat, Placer County; vein quartz near Los Angeles; and vein or pegmatite quartz at Orosi, Tulare County. The sales amounted to 3,620 short tons, both crude and ground, valued at $19,602. Prices for crude were $1.50 to $4 and for crushed or ground $10 to $15 per ton. The quartz was used for pottery, enamel, abrasives, soap, filters, paint, facing concrete ("artificial stone"), silica brick, metallurgical flux, and in foundry work.

California also produces considerable diatomaceous earth.

Colorado.—A very small quantity of silica obtained near Wray, Colo., was sold in 1915.

Connecticut.—Quartz from Long Hill, Fairfield County, and Roxbury, Littlefield County, Conn., was ground and sold in the Bridgeport Wood Finishing Co.'s mill at Still River. A small quantity was sold crude. The material was derived from quartz veins and was used for soap, pottery, paint, and wood filler.

Connecticut also produces silica in the form of diatomaceous earth.

Illinois.—Illinois produces a large quantity of sand and sandstone, of which 33,046 short tons, valued at $105,072, were ground in 1915 and were sold for pottery, paints, soaps, and foundry uses.

Three companies reported grinding in Ogle and La Salle counties.

Illinois also contributes largely to the silica supplies of the country from the tripoli deposits in Alexander and Union counties.

Maine.—Maine in 1915 produced some quartz as a by-product in feldspar mining.

Maryland.—In Maryland five firms, three of which are grinders, reported production in 1915 amounting to 6,207 short tons, valued at $36,857. The material was obtained from veins and pegmatites in Carroll, Harford, and Montgomery counties. Crude quartz sold at $3.50 to $5 and crushed and ground quartz at $6 to $12 per ton. The production in 1915 of ground silica derived from quartz sand was much larger than that from other sources. This material came from Washington County and sold at $4 to $5 per ton.

Maryland also produces diatomaceous earth.

Massachusetts.—In Cheshire, Berkshire County, Mass., large quantities of quartzite are quarried. Most of this is used as "glass sand"

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and is reported in the chapter on that subject. One company marketed a considerable quantity for abrasive purposes.

Michigan.—In Michigan there was one producer, as in previous years, with mine and mill at Ishpeming, Marquette County, and another mill at Milwaukee, Wis. Its product is derived from vein quartz and is used chiefly for paint and wood filler, but also as a polisher.

New York.—One quartz quarry at Bedford, Westchester County, N. Y., was operated in New York in 1915. The product was ground in Connecticut and used for pottery paint, wood filler, and soap.

North Carolina.—As usual in North Carolina, there was in 1915 a single producer of quartz, who quarried quartzite at Mount Holly, in Gaston County. The output was used for packing acid towers.

Ohio.—No production of quartz was reported from Ohio in 1915. However, large quantities were ground in the State and sold to local pottery and other manufactories.

Pennsylvania.—In 1915 quartz was marketed by two producers in Pennsylvania, one in Adams County, operating a quartz-grinding mill, and one in Chester County. Quartz sands and sandstones for other purposes are mined and milled in the State and much of the product here considered as originating in other States was ground in Pennsylvania.

Tennessee.—In 1915 Tennessee produced more quartz than all the other States combined, but the output was of comparatively low grade and of small value. The Tennessee Copper Co. reported a large production quarried from quartzite and used as flux in copper smelting.

Virginia.—Sand dug at Mendota, Washington County, Va., in 1915, was ground in Bristol, Tenn., for use in polishing and cleansing compounds.

West Virginia.—One producer at Berkeley Springs, Morgan County, W. Va., ground sand for the purposes here considered.

Wisconsin.—One firm operating in Flieth, Marathon County, Wis., produced quartz in 1915. The product is derived from a very pure quartzite and is used for filter beds, for roofing, for concrete work, for chicken grits, and for sandpaper.

FLINT OR CHERT.

PRODUCTION.

So far as can be learned no flint (proper) or chert was produced for consumption as crushed or ground silica or for use as pebbles in grinding mills in the United States in 1915.

A new industry for the country as well as the State was inaugurated by the American Flint Co. (Ltd.), at Iron City, Tenn. This firm began the manufacture and made a small production of tube mill lining. The Fort Payne chert in Lawrence and Wayne counties is quarried and cut to dimensions for this purpose.

IMPORTS.

The Department of Commerce records imports of "flint, flints, and flint stones, unground" from various countries. These imports are partly flint pebbles for use in grinding mills and partly material for

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such use as are listed in this report. Separation or classification of these materials represented by the following figures is impossible.

The imports for consumption of flint into the United States in 1915 were valued at $274,904, as compared with $432,694 in 1914, $324,662 in 1913, $289,904 in 1912, $236,158 in 1911, $307,286 in 1910, and $301,547 in 1909.

A detailed table of imports of flint pebbles of various kinds, by countries, and a discussion of domestic substitutes for foreign flint pebbles is given in the chapter on abrasives in Mineral Resources for 1915.

TRIPOLI.

The material commercially called tripoli in the United States is a residue from siliceous limestones, which have been leached of their carbonate content. This material is nearly pure silica of very fine grain and may be either coherent or pulverulent. Tripoli is also used as an abrasive, and is therefore discussed in the chapter on abrasive materials. The statistics of the production of tripoli are there given, but much of the output in Illinois and Missouri is used for the same purposes as the other forms of silica treated in this chapter. The production in those States in 1915 is repeated here:

Tripoli sold in Illinois and Missouri in 1915.

State.	Quantity (short tons).	Value.
Illinois	23,756	$502,937
Missouri	6,870	68,451

DIATOMACEOUS EARTH.

Diatomaceous earth is made up largely of silica. It is a variety of opal—that is, amorphous silica combined with a small quantity of water. It represents the remains of aquatic plants known as diatoms. Diatomaceous earth, which is also commercially called infusorial earth, kieselguhr, and rarely in the United States, although properly, tripoli, is largely used as an abrasive material and is treated in the chapter on abrasive materials. The statistics of production are repeated here because the material is to some extent similar in composition and character to the other materials here considered and because it is in part put to the same uses.

Diatomaceous earth sold in the United States in 1915.

State.	Quantity (short tons).	Value.
California, Nevada, Oregon, and Washington	3,850	$25,865
New Hampshire, Massachusetts, Connecticut, New York, Maryland, and Virginia	743	12,652
	4,593	38,517

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TALC AND SOAPSTONE.

By J. S. DILLER.

DEVELOPMENT OF TALC AND SOAPSTONE INDUSTRY.

The United States leads the world in the production and use of talc and soapstone, and in 1915 the production in this country was greater than ever before.

The domestic output of talc and soapstone for the last 15 years has ranged from a minimum of 86,901 short tons, valued at $840,060, in 1903 to 186,891 short tons, valued at $1,891,582, in 1915, and the development has been approximately uniform.

Talc and soapstone sold in the United States, 1914–15.

State.	1914		1915		Increase or decrease in 1915.		Percentage of increase or decrease in 1915.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
California	547	$8,786	712	$7,185	+ 165	−$1,601	+30	−18
Georgia	(a)	(a)	498	12,050	(b)	(b)	(b)	(b)
New Jersey and Pennsylvania	7,732	54,549	7,989	56,466	+ 257	+ 1,917	+ 3	+ 4
New York	86,075	821,286	88,214	864,843	+ 2,139	+43,557	+ 2	+ 5
North Carolina	1,198	28,413	1,454	21,501	+ 256	− 6,912	+21	−24
Vermont	50,698	363,465	62,497	409,652	+11,799	+46,187	+23	+13
Virginia	21,687	527,938	22,741	504,742	+ 1,054	−23,196	+ 5	− 4
Other States a	4,359	60,650	2,786	15,143	b− 1,075	b−33,457	b−25	b−55
	172,296	1,865,087	186,891	1,891,582	+14,595	+26,495	+ 8	+ 1

a 1914: Georgia, Maryland, Massachusetts, and Rhode Island; 1915: Maryland, Massachusetts, and Rhode Island.
b Increase for Georgia included with "Other States."

North Carolina, Vermont, and Virginia produce both talc and soapstone; Rhode Island and Maryland produce soapstone only; New York, New Jersey, Pennsylvania, California, Georgia, and Massachusetts produce talc only.

By far the greater portion of the marketed product is ground, but the most valuable portion is the manufactured products, especially pencils, crayons, and burner blanks for gas tips, which require talc of high grade. Most of the high-grade material comes from North Carolina and Georgia, and the demand greatly exceeds the supply.

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Classification of talc and soapstone sold in the United States, 1914 and 1915.

Condition in which sold.	1914			1915		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
Rough	3,080	$17,941	$5.83	8,535	$59,392	$6.96
Sawed into slabs	2,913	80,238	27.54	2,090	47,070	22.52
Manufactured articles[a]	17,824	498,802	27.98	16,088	444,679	27.64
Ground[b]	148,479	1,268,106	8.54	160,178	1,340,441	8.37
	172,296	1,865,087	10.82	186,891	1,891,582	10.12

[a] Includes bath and laundry tubs; fire brick for stoves, heaters, etc.; hearthstones, mantels, sinks, griddles, slate pencils, gas tips, burner blanks, crayons, and numerous other articles for everyday use.
[b] For foundry facings, paper and paint, lubricators for dressing skins and leather, etc.

TALC.

PRODUCTION.

In 1915 there were 166,336 short tons of talc produced and marketed in the United States, at a value of $1,401,197. This exceeded the output in 1914 by 15,248 short tons and $60,323 in value.

The relative rank of the nine producing States as to quantity and value of output in 1915 is given in the following table. The production of Pennsylvania and New Jersey and that of Georgia and Massachusetts are combined in order that the output of individual producers be not revealed.

Talc sold in the producing States in 1914 and 1915.

Rank (1915) and State.	1914		1915	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1. New York	86,075	$821,286	88,214	$864,843
2. Vermont	50,123	358,465	61,997	406,652
3. Pennsylvania and New Jersey	7,732	54,549	7,989	55,466
4. Virginia	1,786	11,448	3,036	18,579
5. Georgia and Massachusetts	3,627	57,927	2,934	25,971
6. North Carolina	1,198	28,413	1,454	21,501
7. California	547	8,786	712	7,185
	151,088	1,340,874	166,336	1,401,197

In quantity and value of talc output New York ranks first in the United States and furnishes 53 per cent of all the talc produced in the country. Vermont ranks second, producing 37 per cent of the total talc output of the country. Each of these produce much more talc than all the other seven States combined.

The production of New York in 1915 showed a gain of 2 per cent in quantity over the production of 1914, but the gain in Vermont in 1915 was nearly 24 per cent.

In 1915 by far the greater part of the total output of talc, 158,062 short tons, was sold as ground, at a total value of $1,330,389, or $8.42 per ton, and 25 short tons were sold as manufactured, at a value of $7,980, or $319 per ton.

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IMPORTS.

The talc imported for consumption in 1915, including crude, ground, and manufactured, amounted to 18,069 short tons, valued at $199,840, an increase of 14.8 per cent in quantity and of 12.6 per cent in value as compared with corresponding imports for 1914.

Talc imported for consumption into the United States, 1905 and 1908–1915.

Year.	Quantity (short tons).	Value.	Average price per ton.	Year.	Quantity (short tons.)	Value.	Average price per ton.
1905	4,000	$48,225	$12.05	1912	10,989	$122,956	11.19
1908	7,429	97,096	13.07	1913	13,770	137,680	10.00
1909	4,417	56,287	12.74	1914	15,734	177,321	11.21
1910	8,378	106,460	12.71	1915	18,069	199,840	11.06
1911	7,113	88,050	12.38				

General imports of talc, ground or manufactured, into the United States, 1914 and 1915.

Country.	1914			1915[a]		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
Argentina						
Austria-Hungary	587	$10,814	$18.43	138	$3,019	$21.88
Belgium						
Canada	5,006	56,052	11.20	4,797	57,961	12.08
England	62	853	13.76			
France	4,398	23,022	5.24	3,734	19,253	5.16
Germany	53	5,966	112.55	8	1,888	236.00
Italy	5,535	79,795	14.41	7,268	104,403	14.36
Netherlands						
Japan	3	47	15.66			
	15,644	176,549	11.29	15,945	186,524	11.70

[a] Figures furnished by the Department of Commerce, May 6, 1916. The values given "are the actual market values and wholesale prices of the merchandise at the time of exportation to the United States in the principal markets of the country whence the same has been imported."

Nearly half the talc imported ground or manufactured in 1915 came from Italy, and most of the remainder came from Canada and France.

The shipments of talc from quarries and mills in Canada in 1915,[1] including both crude and ground, was 11,885 short tons, valued at $40,554, or $3.41 per ton. Of the total quantity shipped, 40 per cent came to the United States.

The imported talc is chiefly of the higher grades, used for making toilet powder and gas tips, for which purpose the supply in the United States is not equal to the demand.

PRICES.

The average price of the domestic talc marketed in 1915 was $8.42 per short ton, a decrease of 45 cents from the average price for 1914. The price depends on the quality and use, which determine the form

[1] McLeish, John, Preliminary report on the mineral production of Canada during 1915.

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for marketing. Crude talc is sold generally for $3 to $5 per ton; ground talc for $5 to $10 per ton. Some of the manufactured high-grade talc has been valued at more than $200 per ton.

SOAPSTONE.

In the production of soapstone the United States has first rank among all countries. The output in 1915 was 20,555 short tons, valued at $490,385, a decrease of 653 short tons, or 3 per cent, in quantity and of 6 per cent in value as compared with the production of 1914. Virginia produced more than 23 times as much as the four other States combined, although its production in 1915 was 196 short tons less than in 1914. The decrease in the other States which are combined was even greater, amounting to 35 per cent in quantity and 45 per cent in value.

Soapstone sold in 1914 and 1915.

State.	1914		1915	
	Quantity (short tons.)	Value.	Quantity (short tons.)	Value.
Maryland, North Carolina, Rhode Island, Vermont	1,307	$7,723	850	$4,222
Virginia	19,901	516,490	19,705	486,163
	21,208	524,213	20,555	490,385

Maryland and Vermont, each having one quarry, are practically the only soapstone-producing States besides Virginia, where there were five producers for a part of the year, one of the mines having been in operation only two months. The waste from breakage in quarrying, sawing into slabs, manufacturing, and final transportation is so great as to render success in the industry a matter of skillful manipulation.

The value of the stone is in large measure proportionate to the work upon it. In the rough it is valued at $2 or less per ton, but when sawed into slabs its value is increased to about $15, and later when made into laundry tubs it may attain a value of about $30 per ton.

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ABRASIVE MATERIALS.

By FRANK J. KATZ.

INTRODUCTION.

Industrial operations employ a great variety of abrasive materials. This chapter is concerned with only those mineral products which, as such or as essential constituents of manufactured products, are used for grinding and polishing and other abrasive operations, and it includes the statistics of production, as to both quantity and value, either of the raw material alone or of such material as at most has not been advanced beyond that stage of manufacture at which it is sold by the mine or quarry operator.

Artificial abrasives are included for comparison and because of their strong influence on the industry and markets of natural abrasives.

The statistics are given herein of only that part of the production of any mineral material that properly enters into the abrasive industries. Thus, only a small percentage of the sandstone quarried is used in the manufacture of abrasives, grindstones, and pulpstones, the remainder being used chiefly in the building industry. The segregation of the production is not difficult in this instance, but there is difficulty in separating the production of the diatomaceous (infusorial) earth which is used strictly for abrasive purposes from that which is used in manufacture of filters or of insulating or fireproofing material. Here the total production must be included.

On the other hand, quartz and feldspar, both of which are used as abrasives, are excluded from this discussion because the precise separation according to their uses of these materials can not be made, their principal uses being for purposes other than abrasive, and therefore they are considered in other chapters.

CONSUMPTION.

The total value of the abrasive materials which are considered in this chapter and which entered trade increased about 22 per cent in 1915, as compared with 1914. There was an increase in domestic production of natural and artificial abrasives, but a decrease in imports. The value of natural abrasives produced increased about 33 per cent; of artificial abrasives, about 32 per cent; and imports decreased about 26 per cent.

Among the natural abrasives a gain was shown in the production of millstones, emery, tripoli, and pumice. There was a decrease in quantity and value of grindstones and pulpstones, oilstones and scythestones, garnet, and diatomaceous earth. The total estimated value of all the abrasive materials consumed in the United States during the seven years 1909 to 1915, inclusive, is given in the following

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table, and the value of abrasive materials imported into the United States for consumption in the last four years is given for comparison in the second table.

Value of all abrasive materials[a] consumed in the United States, 1909–1915.

Year.	Natural abrasives.	Artificial abrasives.	Imports.	Total value.
1909	$1,329,750	$1,365,820	$653,779	$3,349,349
1910	1,406,805	1,604,030	977,718	3,988,553
1911	1,526,763	1,493,040	815,854	3,835,657
1912	1,601,993	1,747,120	898,892	4,248,005
1913	1,648,578	2,017,458	916,913	4,582,949
1914	1,310,042	1,685,410	728,710	3,724,162
1915	1,662,055	2,248,778	540,783	4,451,616

[a] Exclusive of feldspar and the various forms of quartz. See chapters on feldspar and silica (quartz).

Value of abrasive materials imported for consumption in the United States, 1912–1915.

Material.	1912	1913	1914	1915
Millstones and burrstones	$27,562	$40,198	$15,000	$17,027
Grindstones	131,080	139,386	109,539	68,892
Hones, oilstones, and whetstones	45,398	40,222	33,655	14,247
Emery and corundum	491,725	474,299	383,436	271,649
Diatomaceous earth, tripoli, and rottenstone	24,253	28,696	20,004	27,333
Pumice	74,478	93,408	92,668	65,691
Diamond dust and bort	94,396	100,704	74,408	75,944
	888,892	916,913	728,710	540,783

NATURAL ABRASIVES.

Under the head of natural abrasives in this report are included (1) millstones and related quarry products, such as chasers and drag stones, (2) grindstones and pulpstones, (3) oilstones and scythestones, (4) corundum and emery, (5) abrasive garnet, (6) diatomaceous (infusorial) earth and tripoli, and (7) pumice. The difficulty of separating abrasive quartz and feldspar from the quartz and feldspar produced for other purposes has led to their omission from the chapter on abrasives, and such information as appears about them in Mineral Resources will be found in chapters entitled "Feldspar" and "Silica" (quartz).

Natural abrasives were produced in 1915 in 24 States, which are listed below:

Arkansas.....Oilstones.
California.....Diatomaceous (infusorial) earth and pumice.
Connecticut.....Diatomaceous (infusorial) earth.
Georgia.....Tripoli.
Illinois.....Tripoli.
Indiana.....Oilstones and rubbing stones.
Kansas.....Pumice.
Kentucky.....Hones.
Maryland.....Diatomaceous (infusorial) earth.
Massachusetts.....Diatomaceous (infusorial) earth.
Michigan.....Grindstones and scythestones.
Missouri.....Tripoli.
Nebraska.....Pumice.
Nevada.....Diatomaceous (infusorial) earth.
New Hampshire.....Garnet, scythestones, and diatomaceous (infusorial) earth.
New York.....Millstones, emery, garnet, and diatomaceous (infusorial) earth.
North Carolina.....Millstones.

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Ohio.....Grindstones, pulpstones, hones, oilstones, scythestones, and rubbing stones.
Oregon.....Diatomaceous (infusorial) earth.
Pennsylvania.....Millstones, oilstones, and rottenstone.
Vermont.....Scythestones.
Virginia.....Millstones and diatomaceous (infusorial) earth.
Washington.....Diatomaceous (infusorial) earth
West Virginia.....Grindstones.

Value of natural abrasives produced and marketed in the United States, 1911–1915.

Abrasive.	1911	1912	1913	1914	1915
Millstones	$40,069	$71,414	$56,163	$43,316	$53,480
Grindstones and pulpstones	907,316	916,339	855,627	689,344	648,479
Oilstones and scythestones	214,991	232,218	207,352	167,948	115,175
Emery	6,778	6,652	4,785	2,425	31,131
Garnet	121,748	163,237	183,422	145,510	139,584
Abrasive quartz and feldspar	(a)	(a)	(a)	(a)	(a)
Diatomaceous (infusorial) earth and tripoli	147,462	125,446	285,821	252,327	611,021
Pumice	88,399	86,687	55,408	59,172	63,185
	1,526,763	1,601,993	1,648,578	1,310,042	1,662,055

a See chapters on feldspar and silica (quartz).

MILLSTONES.

PRODUCTION.

The marketed production of millstones (burrstones) and related quarry products, chasers, dragstones, and pavers in the United States amounted to $53,480, an increase of 23 per cent as compared with 1914. The production in this country in 1915 was less than in 1912 and in 1913 but larger than in any other year of the preceding decade.

The setback suffered by the millstone market because of the introduction of modern grain-milling machinery has been offset to some extent in the last 20 years by the growing use of millstones for grinding mineral products such as feldspar, quartz, and pigments.

American millstones have been and are still for the most part made of quartz sandstones and conglomerates. Some are made of granite. The production recorded in the Survey's reports on mineral resources is only that which has been made for other than purely local use. A small number of stones for local use have been made, particularly in the mountain sections of the Southern States, and various hard quartz or other rocks have been so employed.

Millstones were produced in 1915 in New York, North Carolina, Pennsylvania, and Virginia. Only these States and Alabama have produced them in recent years.

The output increased slightly in New York, about 15 per cent in Virginia, about 35 per cent in Pennsylvania, and nearly 100 per cent in North Carolina.

Value of millstones produced and marketed in the United States, 1910–1915.

State.	1910	1911	1912	1913	1914	1915
New York	$13,753	$13,335	$34,246	$21,987	$16,748	$16,883
Virginia	5,273	17,635	25,866	23,530	20,100	23,170
North Carolina	9,191	9,099	9,352	8,772	5,164	13,427
Pennsylvania			1,950	1,874	1,304	
Alabama						
	28,217	40,069	71,414	56,163	43,316	53,480

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Value of millstones produced and marketed in the United States, 1880–1915.

1880	$200,000	1892	23,417	1904	37,338
1881	150,000	1893	16,639	1905	37,974
1882	200,000	1894	13,887	1906	48,590
1883	150,000	1895	22,542	1907	31,741
1884	150,000	1896	22,567	1908	31,420
1885	100,000	1897	25,932	1909	35,393
1886	140,000	1898	25,934	1910	28,217
1887	100,000	1899	28,115	1911	40,069
1888	81,000	1900	32,858	1912	71,414
1889	35,155	1901	57,179	1913	56,163
1890	23,720	1902	59,808	1914	43,316
1891	16,587	1903	52,552	1915	53,480

IMPORTS.

The imports of burrstones for consumption in the United States in 1915 were larger than in 1914, but less than in 1913 by more than 50 per cent. In 1915 there was recovery in the material imported both in the rough and in finished stones. Shortage in imports occasioned some inquiry for a domestic stone to supplant the French burr. Native stone of such character is unknown, and there seems to be little likelihood of finding any.

Value of burrstones and millstones imported for consumption in the United States, 1910–1915.

Year.	Rough.	Made into millstones.	Total.	Year.	Rough.	Made into millstones.	Total.
1910	$33,740	$1,023	$34,763	1913	$36,276	$3,922	$40,198
1911	35,153	875	36,028	1914	14,291	709	15,000
1912	26,236	1,326	27,562	1915	16,045	982	17,027

THE MILLSTONE INDUSTRY.

In this report for 1909 and for 1913 descriptive notes were given on the millstone industry in New York and Virginia. As the industry is one which undergoes little change from year to year, statements made in former reports may be consulted to supplement the data for 1915 in this report.

New York.—For many years New York led in the production of millstones and chasers (stones which run on edge or on a horizontal shaft). The raw material is obtained in Ulster County, southeastern New York, and is known as Esopus stone, Esopus being an early name for Kingston, which was formerly the main point of shipment. The material suitable for millstones is a white quartz conglomerate or coarse sandstone, and is quarried from the Shawangunk conglomerate, which is found near the western base of Shawangunk Mountain, in the valley of Rondout River. This material is exceedingly scanty, being confined in linear extent to a strip extending from High Falls on the north to Kerhonkson on the south, a distance of approximately 10 miles. Beyond these limits the texture and other properties of the rock have been found unsuitable for the highest grade of stones. Twelve operators reported production of millstones in 1915.

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Virginia.—The millstone industry in Virginia is confined to quarries near Prices Fork, Montgomery County, about 5 miles west of Blacksburg, the site of the Virginia Polytechnic Institute. The rock is of Mississippian (lower Carboniferous) age. The material from which the stones are quarried varies from conglomerate to a fine-grained quartzitic rock. It includes pebbles, some of them as large as walnuts, though most of them are smaller. The rock has a bluish cast. It underlies Brush Mountain for miles, and for this reason the millstones are frequently termed Brush Mountain stones. The stones can not be quarried by blasting, and are therefore extracted by hand power, with drill and hammer, plug, and feathers. Millstones and drag or rider stones are the principal products made at the Virginia quarries. Three operating firms or individuals reported production during 1915.

North Carolina.—In North Carolina at Parkewood, Moore County, a quartz conglomerate known commercially as the North Carolina grit has been used for making millstones. At Faith and near Salisbury in Rowan County a granite is quarried and made into millstones, mostly for grinding corn and oats in North Carolina and Georgia and other Southern States. Two operators reported production of millstones in 1915.

Pennsylvania.—In Lancaster County a quartz conglomerate which has been known to the trade as Cocalico stone is made into millstones. Two manufacturers reported production in 1915.

Alabama.—Near Dutton, Jackson County, millstones have been made from sandstones of Pennsylvanian age. No stones were manufactured in 1915.

Vermont.—A quartz conglomerate rock similar to the New York Esopus stone is found near Fair Haven, Rutland County. No millstones have been made of this rock in recent years.

Ohio.—At Peninsula, in Summit County, a white variety of the Berea grit was quarried for the purpose of grinding oatmeal and pearling barley, for which it was said to be especially well adapted. At present no millstones are made from the Berea grit.

California.—It was reported many years ago that on an eminence known as Little Butte, in Owens River valley, a rock suitable for the manufacture of burrstones was found. It is said to be hard, brecciated, and very much like the French burrstone.

In addition to these localities stones of different varieties and more or less suitable for coarse work are or have been quarried and fashioned for use in local mills in many States.

GRINDSTONES AND PULPSTONES.

PRODUCTION.

The value of the grindstones and pulpstones produced in the United States in 1915 was $648,479, a decrease of $40,865, or nearly 6 per cent, as compared with $689,344, the value for 1914. The decrease is in the value of the grindstones, the production of pulpstones having increased very materially.

The States and the number of quarries in each State producing grindstones in 1915 were: Michigan, 3 quarries; Ohio, 25 quarries;

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and West Virginia, 1 quarry. Ohio, as usual, maintained the leading position in the industry, the value of the output of the State being about eight times that of Michigan. The output of West Virginia was comparatively small. Ohio also produced pulpstones from 3 quarries. Montana and Utah have ceased to be producers of grindstones.

Value of grindstones and pulpstones produced and marketed in the United States, 1911–1915.

State.	1911	1912	1913	1914	1915
Colorado	(a)				
Michigan	(a)	(a)	(a)	(a)	(a)
Montana	(a)	(a)			
Ohio	$742,107	$787,621	$737,572	$606,001	$571,113
Utah		(a)			
West Virginia	(a)	(a)	(a)	(a)	(a)
Other States	[b]165,209	[c]128,718	[d]118,055	[d]83,343	[d]77,366
	907,316	916,339	855,627	689,344	648,479

[a] Included in "Other States."
[b] Includes Colorado, Michigan, Montana, and West Virginia.
[c] Includes Michigan, Montana, Utah, and West Virginia.
[d] Includes Michigan and West Virginia.

Value of grindstones and pulpstones[1] produced and marketed in the United States, 1880–1915.

1880	$500,000	1892	$272,244	1904	$881,527
1881	500,000	1893	338,787	1905	777,606
1882	700,000	1894	223,214	1906	744,894
1883	600,000	1895	205,768	1907	896,022
1884	570,000	1896	326,826	1908	536,095
1885	500,000	1897	368,058	1909	804,051
1886	250,000	1898	500,388	1910	796,294
1887	224,400	1899	684,298	1911	907,316
1888	281,800	1900	710,026	1912	916,339
1889	439,587	1901	580,703	1913	855,627
1890	450,000	1902	667,431	1914	689,344
1891	476,113	1903	721,446	1915	648,479

IMPORTS.

The value of the imports of grindstones decreased in 1915 to $68,892, which was 38 per cent less than in 1914 and 51 per cent less than in 1913. The imports for the last six years and the exports for 1914 and 1915 are given below.

Value of grindstones and pulpstones imported for consumption in the United States, 1910–1915.

1910	$106,596	1912	$131,080	1914	$109,539
1911	123,727	1913	139,386	1915	68,892

The value of the grindstones exported from the United States in 1915 was $128,920, against exports valued at $108,040 in 1914.

[1] Pulpstones first reported in 1898.

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CANADIAN PRODUCTION.[1]

The value of the grindstones, scythestones, and wood-pulp stones produced in Canada in 1915 [2] amounted to $35,768, as compared with $54,504 in 1914.

Value of grindstones, etc., produced in Canada, 1910–1915.

1910	$47,196	1912	$52,090	1914	$54,504
1911	52,942	1913	51,325	1915	35,768

OILSTONES AND SCYTHESTONES.

PRODUCTION.

The production of oilstones (including hones and whetstones) and scythestones in the United States during 1915 amounted to $115,175 in value, a decrease of $52,773, or 31 per cent, as compared with the value for 1914. Oilstones were produced in Arkansas, Indiana, Ohio, Kentucky, and Pennsylvania, especially in Arkansas, which has led in the production for many years. Ohio led in the production of scythestones, but New Hampshire, Vermont, and Michigan also contributed important quotas. A description of the scythestone industry in New Hampshire was given in this report for 1909, and a description of Arkansas oilstones, oilstone deposits, and industry was included in the report for 1911.

Value of oilstones and scythestones produced and marketed in the United States, 1880–1915.

1880	$8,000	1892	$146,730	1904	$188,985
1881	8,580	1893	135,173	1905	[7]244,546
1882	10,000	1894	136,873	1906	268,070
1883	10,000	1895	155,881	1907	[3] 264,188
1884	12,000	1896	127,098	1908	[3] 217,284
1885	15,000	1897	149,970	1909	[4] 214,019
1886	15,000	1898	180,486	1910	[3] 228,694
1887	16,000	1899	208,283	1911	[4] 214,991
1888	18,000	1900	174,087	1912	[4] 232,218
1889	32,980	1901	158,300	1913	[4] 207,352
1890	69,909	1902	221,762	1914	[5] 167,948
1891	150,000	1903	366,857	1915	[6] 115,175

IMPORTS.

Value of hones, oilstones, and whetstones imported for consumption in the United States, 1910–1915.

1910	$45,819	1912	$45,398	1914	$33,655
1911	54,379	1913	40,222	1915	14,247

[1] From reports of Canada Dept. Mines.
[2] Preliminary report on the mineral production of Canada during 1915: Canada Dept. Mines, 1916.
[3] Includes a quantity of "rubbing stone" quarried in Indiana.
[4] Includes a quantity of honestone quarried in Kentucky and "rubbing stone" quarried in Indiana.
[5] Includes a quantity of honestone quarried in Kentucky and Pennsylvania and "rubbing stone" quarried in Indiana.
[6] Includes a quantity of honestone quarried in Kentucky and Ohio and "rubbing stone" quarried in Indiana and Ohio.

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CORUNDUM AND EMERY.

PRODUCTION.

The United States produced no corundum in 1915 and has produced none since 1906.

The domestic production of emery in 1915 appears to have come entirely from the region near Peekskill, in Westchester County, N. Y. The Survey received no report of production in 1913, 1914, and 1915 from the mines in Chester, Hamden County, Mass., which had for many years produced an annually diminishing quantity. The returns from New York producers are incomplete, and the entry in the following table for 1915 is an estimate, which is, however, believed to be a close approximation to the quantity actually produced. The value given in the table is merely an estimate of the cost of mining and preparing the material as shipped from the mines, based on reports made by some of the producers. The estimated domestic production for 1915 is 3,063 short tons, which is 2,578 tons, or about 531 per cent, more than the estimated output for 1915. The estimated value of the output for 1915 (cost of production) is $31,131, which is $28,706, or about 1,183 per cent, more than that for 1914. The decrease in emery imports seemingly resuscitated American emery mining.

Corundum and emery produced and sold in the United States, 1881–1906.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1881	500	$80,000	1890	1,970	$89,395	1899	4,900	$150,600
1882	500	80,000	1891	2,247	90,230	1900	4,305	102,715
1883	550	100,000	1892	1,771	181,300	1901	4,305	146,040
1884	600	108,000	1893	1,713	142,325	1902	4,251	104,605
1885	600	108,000	1894	1,495	95,936	1903	2,542	64,102
1886	645	116,190	1895	2,102	106,256	1904	1,916	56,986
1887	600	108,000	1896	2,120	113,246	1905	2,126	61,464
1888	589	91,620	1897	2,165	106,574	1906	1,160	44,310
1889	2,245	106,567	1898	4,064	275,064			

Emery produced and sold in the United States, 1907–1915.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1907	1,069	$12,294	1910	1,028	$15,077	1913	[a] 957	[a] $4,785
1908	669	8,745	1911	659	6,778	1914	[a] 485	[a] 2,425
1909	1,580	18,185	1912	992	6,652	1915	[a] 3,063	[a] 31,131

[a] Estimated.

IMPORTS.

The following table gives the quantity and value of the emery and corundum imported into the United States from all foreign countries during recent years. The year 1915 was marked by decrease in the total value of imports of all forms of emery and corundum, amounting to 29 per cent as compared with 1914 and 42 per cent as compared with 1913. The imports have fluctuated irregularly in both quantity and value during the last decade. Nevertheless, the 1915 figures establish a veritable low-water mark, for which the war's interference with

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mining in Turkey and Greece and with Mediterranean shipping is responsible.

Emery and corundum imported for consumption in the United States, 1910–1915.

Year.	Grains.		Ore and rock.		Other manufactures.	Total value.
	Quantity.	Value.	Quantity.	Value.	Value.	
	Pounds.		*Long tons.*			
1910	2,311,464	$106,570	28,948	$509,661	$13,527	$629,758
1911	1,382,813	76,027	10,822	245,459	15,158	336,644
1912	2,135,922	105,325	16,391	369,529	16,871	491,725
1913	2,496,372	114,786	17,123	342,809	16,704	474,299
1914	1,781,821	79,989	12,909	290,866	22,581	393,436
1915	1,277,673	56,254	8,462	197,303	18,092	271,649

CANADIAN CORUNDUM.

Canadian corundum shipped, 1910–1915.[a]

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	1,870	$198,680	1913	1,177	$137,036
1911	1,472	161,873	1914	548	72,176
1912	1,960	239,091	1915	339	37,798

[a] Figures taken from the annual reports on mineral production of Canada, Canada Dept. Mines.

ABRASIVE GARNET.

PRODUCTION.

The sales of domestic garnet for use as abrasives in the United States in 1915 amounted to 4,301 short tons, valued at $139,584, an increase of 70 tons, or about 1.5 per cent, in quantity and a decrease of $5,926, or about 4 per cent, in value. The prevailing price for abrasive garnet in 1915 was about $35 a ton, as in recent years, but considerable quantities sold at $20 and $30 a ton.

New York maintained its preeminence as a producer of garnet, having to its credit more than 90 per cent of the total for the United States in 1915. New Hampshire was the only other producing State. The quarries in Connecticut, Pennsylvania, and North Carolina were inactive.

Abrasive garnet produced and sold in the United States, 1894–1915.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1894[a]	2,401	$90,660	1902	3,926	$132,820	1909	2,972	$102,315
1895[a]	3,325	95,050	1903	3,950	132,500	1910	3,814	113,574
1896[a]	2,696	68,877	1904	3,854	117,581	1911	4,076	121,748
1897[a]	2,554	80,853	1905	5,050	148,095	1912	4,947	163,237
1898[a]	2,967	86,850	1906	4,650	157,000	1913	5,308	183,422
1899[a]	2,765	98,325	1907	7,058	211,686	1914	4,231	145,510
1900	3,185	123,475	1908	1,996	64,620	1915	4,301	139,584
1901	4,444	158,100						

[a] Exclusive of North Carolina production for which statistics are lacking.

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TRIPOLI AND DIATOMACEOUS (INFUSORIAL) EARTH.

TRIPOLI.

The material called tripoli in the trade in the United States is a white or yellowish, light, porous, and generally purely siliceous rock which has resulted from the leaching of calcareous material from very siliceous limsetones or highly calcareous cherts. In origin, properties, and some of its uses tripoli is like "rottenstone," which is here classed with it.

Some tripoli from Missouri is and always has been produced primarily for use as an abrasive, but most of it is mined to be worked up into filter blocks of various shapes. The cuttings and waste from making filters are ground and prepared for abrasive and other uses. The Illinois product is used in paint, wood filler, metal polish, in soaps, in cleansers, for making glass, tile, and enamel, and for facing foundry molds.

A definite statement of the exact proportion used as an abrasive has not been obtained from producers of tripoli, nor has any attempt been made to get at the production of rough tripoli blocks worked up into filter stones. Even if this output had been ascertained it would be impossible to value the product on a uniform basis and thus to obtain a reliable ratio between quantity and value, for the reason that the price of filter stones varies and is dependent not only on the size of the stones but also on the work done on each stone.

DIATOMACEOUS EARTH.

Diatomaceous earth, called also infusorial earth and kieselguhr, is a light earthy material which from some sources is loose and powdery and from others is more or less firmly coherent. It often resembles chalk or clay in its physical properties, but can be distinguished at once from chalk by the fact that it does not effervesce when treated with acids. It is generally white or gray in color, but may be brown or even black when mixed with much organic matter.

Diatomaceous earth is made up of remains of minute aquatic plants and is composed, chemically, of hydrous silica.

Owing to its porosity, it has great absorptive powers and high insulating efficiency and is an effective filter. The hardness, the minute size, and the shape of its grains make it an excellent metal-polishing agent.

Heretofore diatomaceous or infusorial earth has been largely used as an abrasive in the form of polishing powders and scouring soaps, but of late its uses have been considerably extended. Because of its porous nature, it has been used in the manufacture of dynamite as a holder of nitroglycerin, but, so far as known, not recently in the United States. It is used by sugar refiners for filtering or clarifying. Its porosity also renders it a nonconductor of heat, and this quality in connection with its lightness has very greatly extended its use as an insulating packing material for safes, steam pipes, and boilers, and as a fireproof building material. In this country it is used in the manufacture of records for talking machines. In Europe, especially in Germany, infusorial earth has lately found extended application. It has been used in preparing artificial fertilizers, especially in the absorption of liquid manures; in the manufacture of water glass, of various cements, of glazing for tiles, of artificial stone, of ultramarine

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and various pigments, of aniline and alizarin colors, of paper, sealing wax, fireworks, gutta-percha objects, Swedish matches, solidified bromine, scouring powders, papier-mâché, and many other articles. There is a steadily growing demand for it.

PRODUCTION.

Tripoli and diatomaceous (infusorial) earth have been combined for consideration in these reports for many years for the reasons (1) that, because of the confusion in names it was not expedient to make the separation in the earlier canvasses after the beginning of the production of what is now called tripoli, and (2) that uses of the materials as abrasives are in part the same. Since 1913 the production of these materials has also been separately considered. The production of tripoli in Missouri has been regularly recorded only since 1889, which accounts for the marked increase in that year.

Diatomaceous earth and tripoli produced and sold in the United States, 1880–1915.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1880	1,833	$45,660	1892	.....	$43,655	1904	6,274	$44,164
1881	1,000	10,000	1893	.....	22,582	1905	10,977	64,637
1882	1,000	8,000	1894	2,584	11,718	1906	8,099	72,108
1883	1,000	5,000	1895	4,954	20,514	1907	14,824	104,406
1884	1,000	5,000	1896	3,846	26,792	1908	.....	97,442
1885	1,000	5,000	1897	3,833	22,835	1909	18,680	122,348
1886	1,200	6,000	1898	2,733	16,691	1910	.....	130,006
1887	3,000	15,000	1899	4,334	37,032	1911	16,662	147,462
1888	1,500	7,500	1900	3,615	24,207	1912	16,706	125,446
1889	3,466	23,372	1901	4,020	52,950	1913	27,383	285,821
1890	2,532	50,240	1902	5,665	53,244	1914	28,230	252,327
1891	.....	21,988	1903	9,219	76,273	1915	35,304	611,021

Tripoli produced and sold in the United States, 1913–1915.

State.	1913		1914		1915	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Illinois	12,994	$128,892	10,387	$59,394	23,756	$502,937
Missouri	7,529	83,995	6,721	81,434	6,955	69,567
Other States[a]	274	3,694	110	1,600		
	20,797	216,581	17,218	142,428	30,711	572,504

[a] 1913: Pennsylvania, Tennessee, and Georgia; 1914: Oklahoma and Pennsylvania; 1915: Pennsylvania and Georgia.

Diatomaceous earth produced and sold in the United States, 1913–1915.

State.	1913		1914		1915	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Western States[a]	6,035	$55,056	10,343	$98,819	3,850	$25,865
Eastern States[b]	551	14,184	669	11,080	743	12,652
	6,586	69,240	11,012	109,899	4,593	38,517

[a] California, Nevada, and Washington, and Oregon in 1915.
[b] 1913: Connecticut, New York, Maryland, Virginia, and Florida; 1914: Massachusetts, Connecticut, New York, and Maryland; 1915: New Hampshire, Massachusetts, Connecticut, New York, Maryland, and Virginia.

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Production of tripoli.—The marketed production of tripoli (and rottenstone) for all purposes in the United States in 1915 was 30,711 short tons, valued at $572,504. This was a large increase—78 per cent in quantity and approximately 300 per cent in value, as compared with 1914—and was due to an exceptionally large output in Illinois, which was sold in prepared form at an abnormally high price. The Missouri production was also in excess of that for 1914, but the reported value is less, being entirely for the crude quarry product.

In Illinois four mines in Union County and one in Alexander County reported production. No new deposits were developed, and a number of mines formerly worked were idle during the year.

In Missouri three operators in Newton County were active in 1915. There were no new developments.

Oklahoma deposits of tripoli were not productive in 1915.

The new operation in Tennessee described in this report for 1913 was suspended in 1914 and 1915.

In Arkansas the deposits of tripoli near Butterfield have not yet become commercially productive.

In Georgia the company operating a deposit of tripoli in Murray County sold a small quantity in 1915.

Pennsylvania produced, as usual, a small quantity of "rottenstone" in Lycoming County in 1915.

Production of diatomaceous earth.—The marketed production in the United States of diatomaceous earth (also called diatomite, infusorial earth, Kieselguhr, tripoli, and tripolite, and sold under various trade names) amounted in part in 1915 to 4,593 short tons, valued at $38,517, besides which there was a considerable production for special uses upon which the Geological Survey is not at liberty to report. Estimates of such production were included in the statement for 1914, and therefore the data for the two years are not comparable.

In 1915 the producing States were California, Connecticut, Maryland, Massachusetts, Nevada, New Hampshire, New York, Oregon, Virginia, and Washington.

The table shows production for 1913, 1914, and 1915 by Western and Eastern States. It will be noted that the production in the Eastern States is small in quantity but valued per ton at two to three times as much as the western output. The difference is due to the fact that the eastern product was sold as high-grade cleansing and polishing preparations, whereas the western product was sold as raw quarry product or went into the manufacture of structural materials and insulation. The difference will probably disappear when the projected industries based on the Maryland-Virginia deposits get under way.

IMPORTS.

Value of tripoli, diatomaceous earth, and rottenstone imported for consumption in the United States, 1910–1915.

1910	$56,657	1912	$24,253	1914	$20,004
1911	35,665	1913	28,696	1915	27,333

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PUMICE.

PRODUCTION.

The marketed production of pumice in the United States in 1915 amounted to 27,708 short tons, valued at $63,185, an increase of 117 tons, or less than 1 per cent, in quantity and of $4,013, or about 7 per cent, in value, as compared with 1914. In 1915 California, Kansas, and Nebraska were the producing States. The production was small and fell off in quantity but increased in value in the first two States; Nebraska's production was about the same as in 1914 and constituted nearly the whole of the domestic output.

The statistics given in the table are of pumice used for abrasive purposes solely. The pumice used for construction—and it is known that some of the domestic article has been so used—is not included. The material has come from several counties in six States: Inyo and Siskiyou counties in California; Harper, Morton, and Phillips counties in Kansas; Furnas, Lincoln, and Harlan counties in Nebraska; Cassia and Power counties in Idaho; Custer County in South Dakota; and Millard County in Utah.

The domestic product is almost wholly a finely comminuted material, volcanic dust or "ash." The imported material, which comes from the Lipari Islands, a group of volcanic islands north of Sicily in the Mediterranean Sea, is a massive, very finely pumiceous or vesicular rock. Very little pumice of this type has been produced in the United States.

Pumice produced and sold in the United States, 1910–1015.

Year.	Quantity (short tons).	Value.	Price per ton.
1910	23,271	$94,943	$4.08
1911	21,689	88,399	4.08
1912	27,146	86,687	3.19
1913	24,563	55,408	2.26
1914	27,591	59,172	2.14
1915	27,708	63,185	2.28

IMPORTS.

Value of pumice imported for consumption in the United States, 1910–1915.

1910	$104,425	1912	$74,478	1914	$92,668
1911	118,977	1913	93,408	1915	65,691

PEBBLES FOR GRINDING.

Pebbles used for grinding minerals, ores, cement materials, and clinker may be properly considered abrasive materials. This report prior to 1914 had not included them because none had been produced in the country, except for limited local use of which no record was obtained, and also because the records of imports of foreign pebbles for grinding are not kept separate from those of pebbles which are crushed and used as "flint" in the ceramic industry. Chapters on quartz or flint in Mineral Resources have annually given the quantity of the imports of pebbles used both for grinding and as flint.

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Little or no interest had been taken in domestic sources of flint pebbles until the fall of 1914, when the threatened interruption of imports from Denmark and France, the principal sources of foreign supply, aroused American jobbers and consumers to seek independence from the established foreign sources.

In the accompanying tables are given the value both of imports "for consumption" and of "general" imports classified according to countries of origin.[1] Both groups of figures are of interest to the present discussion.

Value of pebbles and flint imported for consumption in the United States, 1909–1915.

1909	$301,547	1913	$324,662
1910	307,286	1914	432,694
1911	236,158	1915	274,904
1912	289,904		

Value of pebbles imported into the United States, 1912–1915.

Country.	1912	1913	1914	1915
Belgium	$99,472	$40,947	$70,851	.....
Canada	14,141	8,599	63,996	$1,128
Denmark	78,123	134,625	193,029	152,129
England	870	2,626	2,199	1,303
France	99,140	121,854	116,571	91,024
Germany	67	2	91	.....
Italy	.....	.....	22	.....
Japan	.....	.....	12	97
Newfoundland and Labrador	.....	10,800	8,448	.....
Norway	239	.....	1,846	.....
Sweden	.....	56	22,061	28,088
	292,052	319,509	479,146	273,769

The data in these tables show much larger imports in 1914 and considerably smaller imports in 1915, as compared with 1913. It is not clear whether the falling off in 1915 is due directly to the war or to excessive imports in 1914, but probably to the latter, because the 50 per cent increase in general imports in 1914, as compared with 1913, is seemingly out of all proportion to changes in the industries which use pebbles or flints, and furthermore because there is indicated by comparison of the figures in the tables that a considerable part of the shipments to the United States in 1914 were not "entered for consumption" in that year.

The threatened shortage of imports did not materialize in 1914, for of Danish pebbles the imports exceeded those of 1913 by about 44 per cent and were more than double those of 1912. Furthermore, inspection of the quarterly statements for 1914 shows that imports from all countries amounted to 15, 26, 34, and 25 per cent of the totals for the first, second, third, and fourth quarters, respectively. Imports from countries not directly involved in the war, particularly Sweden and Canada, increased enormously in comparison with previous years, but even if this increase is considered as stimulated by the war because Denmark, Belgium, and France were cut off and if on that account all imports from countries other than Denmark, Belgium, and France are credited to the third and fourth quarters, there still remains 65 per cent of the whole imports for the year,

[1] These figures are not identical because merchandise brought into the country and listed under "general imports" may be put into a warehouse and not be withdrawn for consumption during the calendar year of entry. It is credited "for consumption" to the year of its withdrawal from the warehouse.

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equivalent approximately to 80 per cent of the Danish alone, or 40 per cent of the combined Danish, Belgian, and French pebbles, to be credited to the second half of the year. In spite of the abundance of supplies brought into the United States in the latter half of 1914, price quotations advanced markedly.

In 1915 the total imports fell off 43 per cent as compared with 1914, 14 per cent as compared with 1913, and 6 per cent as compared with 1912. Of the total for the year 1915, 14, 14, 46, and 26 per cent came in during the first, second, third, and fourth quarters, respectively. As shown in the tables, Denmark contributed about 56 per cent of the whole, but a smaller quantity than in 1914, although more than in previous years; Belgium sent none; and the English, Canadian, and French supplies fell off very largely. During this year, however, prices declined toward normal levels.

The exact quantity of pebbles annually imported for grinding is not determinable, as the records show only the total combined value of all kinds of pebbles imported. Apparently the larger part of the imports from Belgium, Denmark, and France are for grinding pebbles and they are flint pebbles. The whole imports from Canada, Newfoundland, and Labrador are probably grinding pebbles that are not flint. Much of the value credited to England and some of that credited to Belgium, Denmark, and France is for flint which, after arrival in this country, is pulverized for use by potters.

Pebbles are used as grinders by revolving them with the material to be ground in troughs of various cylindrical or conical forms. The crushing and the fine grinding are accomplished in part hy the impact of "cascading" pebbles and in part by the slipping or rubbing of the pebbles on the material to be ground. The relative amount of reduction accomplished by these two methods depends, among other things, on the form and the character of the lining of the mill and on the shape of the pebbles. Well-rounded pebbles ranging in diameter from about 1½ to 4 inches are preferred. The pebbles themselves should be hard and tough and not liable to fracture the better to withstand the reduction which they themselves suffer in the grinding mills. In these respects selected Danish and French flint pebbles have proved most acceptable. Danish pebbles are generally in highest favor. Besides Denmark and France, Belgium, Norway, and England have supplied flint pebbles, and grinding pebbles have also been imported from Germany, Italy, Labrador, Newfoundland, and Japan.

Domestic pebbles for grinding.—Information on domestic sources of flint or other grinding pebbles and substitutes therefor is summarized in the report on abrasive materials in Mineral Resources for 1914. Since the preparation of that report no new information has been received and no new developments of American supplies have been reported. The continued adequacy of foreign supply seems to have checked interest in the subject. There is some indication that balls of steel or steel alloys are gaining in favor and displacing flint pebbles.

During the year the American Onyx Co., of Tonopah, Nev., operated the pebble-making plant devised by Omar Maris. This company manufactured pebbles from chalcedonized rhyolite for use by local gold mills. Mr. Maris expects an increase of business in 1916, which may warrant improved equipment and hence a better product.

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ARTIFICIAL ABRASIVES.

The artificial abrasives here considered include carborundum and crystolon, which are carbides of silicon; alundum and aloxite, which are crystalline aluminum oxides; and crushed steel and steel shot. So far as known to the Survey, these are the only artificial abrasives manufactured in the United States. Artificial abrasives with other names are either special forms of the above-named products marketed under trade names or are imported products.

Artificial abrasives sold in the United States, 1906–1915.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1906	11,774,300	$777,081	1911	21,292,000	$1,493,040
1907	14,632,000	1,027,246	1912	29,002,000	1,747,120
1908	8,698,000	626,340	1913	33,499,000	2,017,458
1909	20,468,000	1,365,820	1914	27,191,611	1,685,410
1910	23,027,000	1,604,030	1915	37,684,000	2,248,778

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GRAPHITE.

By EDSON S. BASTIN.

INTRODUCTION.

The form of carbon known as graphite or plumbago occurs in nature in a variety of ways and serves many useful purposes, especially in the manufacture of crucibles and other refractory products, in lubricants, as foundry facings, and in stove polishes. Its properties, origin, uses, and mode of occurrence at the principal localities of the United States have been fully described in the report on graphite in Mineral Resources for 1913, which will be sent free on request to the Director, United States Geological Survey, Washington, D. C. That report also contains a bibliography of the more important publications dealing with the general character of graphite and its occurrence in this country.

Because of its use in the manufacture of crucibles, graphite is a mineral resource of vital importance in time of war. The effect of the European war upon the graphite industry in this country in 1915 is very interesting and will be discussed at some length in another part of this chapter. In general the industry was greatly stimulated by the increased demands for graphite products, particularly crucibles, and many American producers of flake graphite reported greatly increased production. Most crucible makers largely increased their output, though unable to take full advantage of the increased demand because of the difficulty in obtaining adequate supplies of graphite of crucible grade. In the mining and concentration of flake graphite particular activity was displayed in Alabama, where one new plant, built in 1914, became an important producer in 1915, and where three new properties are being opened but have not yet reached the producing stage.

PRODUCTION AND IMPORTS.

The production of natural graphite in the United States in 1915 was approximately 19 per cent, by value, of the graphite imported. In addition to natural graphite, this country produced a considerable quantity of manufactured graphite in the electric furnaces at Niagara Falls. The imports came mainly from the island of Ceylon.

NATURAL GRAPHITE.

PRODUCTION.

As usual, the greater part of the crystalline graphite was produced by New York, Pennsylvania, and Alabama. The production of these States was all of the variety known in the trade as "flake" graphite, which occurs as small flakes forming 5 to 10 per cent, by weight, of crystalline schists, from which it is separated by more or less complicated milling processes. In addition, a small quantity of crystalline graphite, resembling in a general way the Ceylon graphite, was produced in Montana. As a result of increased production in all

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these States, but particularly in Alabama, the quantity of crystalline graphite produced in 1915 exceeded that for any previous year. The number of producers of crystalline graphite were 4 in Alabama, 1 in Montana, 3 in New York, and 2 in Pennsylvania.

Amorphous graphite mined in this country is used locally for foundry facings and paint pigments. Its production was not stimulated by the war and was considerably below that for 1914. There were three producers, located in Nevada, Rhode Island, and Wisconsin.

Details in regard to certain properties are given in the review by States and Territories.

Natural graphite sold, 1911–1915.

Year.	Amorphous.		Crystalline.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Pounds.*		*Short tons.*	
1911	1,223	$32,415	4,790,000	$256,050	3,618	$288,465
1912	2,063	32,894	3,543,771	187,689	3,835	220,583
1913	2,243	39,428	5,064,727	254,328	4,775	293,756
1914	1,725	38,750	5,220,539	285,368	4,336	324,118
1915	1,181	12,358	7,074,370	417,273	4,718	429,631

On account of the small number of producers, figures of production by States, except for Alabama, can not be published without disclosing individual reports. The production of Alabama was 3,474,800 pounds, valued at $204,572, as against 2,410,200 pounds, valued at $118,000, in 1914.

IMPORTS.

The imports of graphite into the United States in 1915 exceeded in value, though not in quantity, those for any previous year. The increase in value was due to the prevailing high prices and to the small quantity of low-grade graphite imported.

The following statistics are from the records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce:

Graphite imported into the United States, 1913, 1914, and 1915.

Country.	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
Ceylon	16,996	$1,674,764	8,374	$920,147	[a] 12,275	$1,564,917
Mexico	4,435	198,000	4,259	190,075	1,680	75,000
Canada	1,662	98,665	1,806	92,536	2,995	116,407
Japan (Chosen via Japan)	4,170	58,199	6,327	96,433	2,373	35,292
Austria-Hungary	660	9,957	78	1,258	.....	.....
Italy	236	4,061	254	3,208	27	994
Germany	90	4,034	.....	.....	.....	.....
England	.....	.....	381	42,446	[b] 2,216	261,321
France	.....	.....	194	20,278	[c] 1,432	181,236
British India	.....	.....	127	9,815	.....	.....
Madagascar	.....	.....	155	18,426	36	2,831
Netherlands	.....	.....	.....	.....	36	2,811
Other countries	630	62,111	47	3,644	5	354
	28,879	2,109,791	22,002	1,398,261	23,075	2,241,163

[a] Entered in reports of Department of Commerce as "Other British East Indies."
[b] Probably Ceylon graphite reshipped from England.
[c] Probably Madagascar graphite reshipped from France.

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The imports credited to England and France in the table probably represent, respectively, Ceylon and Madagascar graphite. No graphite mined in England or France is known to have come into this country in 1915, but the embargoes placed, late in 1914, on Ceylon and Madagascar graphites prohibited their shipment to any but British and French ports. From these ports some of the graphite was reshipped to the United States.

Graphite imported into the United States, 1910–1915.

Year.	Quantity.	Value.	Year.	Quantity.	Value.
	Short tons.			*Short tons.*	
1910	25,235	$1,872,592	1913	28,879	$2,109,791
1911	20,702	1,495,729	1914	22,002	1,398,261
1912	25,643	1,709,337	1915	23,075	2,241,163

WORLD'S PRODUCTION.

The figures of production of graphite for 1913 are available for few countries.

World's production of natural graphite, 1911, 1912, and 1913.

Country.	1911 [a]		1912 [a]		1913	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.		*Short tons.*		*Short tons.*	
United States	3,618	$288,465	3,835	$220,583	4,775	$293,756
Canada	1,269	69,576	2,059	117,117	[b] 2,162	90,282
Mexico	3,050	36,353	3,158	96,668	(c)	(c)
Russia	(c)	(c)	(c)	(c)	(c)	(c)
Germany	12,454	72,754	13,814	81,514	(c)	(c)
Austria	46,855	332,489	50,017	378,867	(c)	(c)
Norway			285	1,898	(c)	(c)
Sweden	72	2,097	87	2,535	[e] 88	(c)
France	408	3,601	661	1,635	(c)	(c)
Italy	13,912	74,701	14,517	77,236	(c)	(c)
Japan	126	8,911	163	10,935	[f] 11,037	[f] 116,389
China	22	1,728	(c)	(c)	(c)	(c)
Chosen (Korea)		[d] 65,727		82,108	(g)	(g)
India	4,533	45,867	(c)	(c)	[h] None.	[h] None.
Ceylon	[d] 30,133	[d] 2,159,529	[d] 36,660	[d] 2,707,973	[i] 28,540	[i] 2,935,529
Madagascar	1,373	48,534	3,011	239,291	(c)	(c)
South Africa	44	6,365	42	5,621	[k] 39	[k] 6,117

[a] Mines and quarries: General Report with Statistics, pt. 4. London.
[b] Canada Dept. Mines Ann. Rept., 1913.
[c] Statistics not available.
[d] Export figures.
[e] Sveriges Officiella Statistik; Bergshantering, 1913.
[f] Mining Industry of Japan, Imperial Bureau of Mines, Tokyo. (Pamphlet prepared for Panama-Pacific International Exposition.) This states that about 93 per cent of this production came from Chosen (Korea).
[g] See footnote (*f*) above.
[h] India Geol. Survey Records, vol. 43, 1913.
[i] Ceylon Blue Book, 1913.
[k] Union South Africa Dept. Mines Ann. Rept., 1913.

MANUFACTURED GRAPHITE.

Graphite in large quantities is manufactured by the Acheson Graphite Co., at Niagara Falls, N. Y., which utilizes electric power generated at the Falls. In 1915 a large new building was erected exclusively for the manufacture of "Gredag," a mixture of grease and graphite used for lubrication. In March, 1916, a new furnace house was in process of erection. When this is completed the com-

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pany will have four furnace houses in Niagara Falls, N. Y., and one in Niagara Falls, Canada, accommodating in all about 40 furnaces.

The demand for graphite electrodes greatly increased during the year on account of the remarkable growth in certain electrochemical industries. The extent of this growth is indicated by the statement [1] that during 1915 the number of electric steel furnaces in operation in this country increased 78 per cent. It is interesting to note that the graphite electrodes made at Niagara Falls range in size from a diameter of one-sixteenth of an inch to a diameter of 12 inches and a length of 77 inches.

The bulk graphite produced by this company in 1915 was reported as 2,542 short tons, valued at $99,633. This represents only the graphite which would come into competition with natural graphite and does not include certain graphitized products that do not compete with natural graphite. This material, most of which is made either from anthracite or from petroleum coke, comes from the furnace in an earthy, incoherent condition, and is utilized mainly in lubricants and paints, and for foundry facings, boiler-scale preventives, and battery fillers.

MARKETS AND PRICES.

The prices paid to importers in New York for Ceylon graphite during 1915 were approximately as follows:

Prices of Ceylon graphite at New York, 1915.

	Cents per pound.		Cents per pound.
Ordinary lump:		Dust:	
Best	9 –22	Best	5 –7½
Medium	7½–15	Medium	4 –6
Poor	6 –12	Poor	3 –6
Chip:		Flying dust:	
Best	7 –15	Best	3 –5
Medium	6 –13	Medium	2½–4
Poor	5 –10	Poor	2 –3

In general the smaller figures represent the prices at the beginning and the larger figures the prices at the end of the year. The increase in price during the year was fairly regular and has continued from the end of 1915 to the date of writing (March, 1916), the best grades of Ceylon lump now selling at 22 to 23 cents per pound. Only small quantities of the poorer grades of Ceylon graphite were imported during 1915, the extraordinary demand for the higher grades and the shortage of bottoms crowding out the cheaper grades. The present high prices are a result of increased demand, increased freight rates, war surcharges, and higher rates of insurance. At the end of 1915 the freight rates from Ceylon were approximately three times what they were before the outbreak of the European war, and early in March, 1916, they had increased to about five and one-half times the antebellum rate. A part of the increase in 1916 is due to the fact that all Ceylon graphite now comes around the Cape of Good Hope instead of by the Suez Canal, to avoid danger of capture or destruction in the Mediterranean.

The graphite-mining industry in Ceylon was in a very depressed condition during 1914 because of shortage of labor and of the unu-

[1] Iron Age, Jan. 6, 1916, p. 95.

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sually heavy rains, which interfered with mining operations. This depression was aggravated by the embargo imposed in October, 1914, on the exportation of graphite to countries other than those of the allies. After the modification of the restrictions on exports to the United States about the middle of 1915 and because of the greatly increased demand for graphite for crucibles to be used in the manufacture of munitions, most of the mines resumed operation.

The exports of graphite from Ceylon to the United States in 1915 considerably exceeded those in 1914, and the loss of the German and Belgian trade was partly compensated by increased exports to the United Kingdom and by large exports to Russia, which hitherto had consumed almost no Ceylon graphite.

The figures for 1913 and 1914 below are taken from the Ceylon Blue Book, and those for 1915 from the report of the Ceylon Chamber of Commerce.

Exports of graphite from Ceylon, 1913–1915, in short tons.

Country.	1913	1914	1915	Country.	1913	1914	1915
United States	14,461	6,928	13,821	Italy	21	5	.....
Germany	6,178	3,148	.....	Holland	8	24	.....
United Kingdom	5,348	2,636	5,389	Japan	107	62	16
Belgium	1,969	865	.....	Russia in Europe	.....	4	1,998
British India	27	58	52	Other countries	74	21	18
Victoria	225	318	244				
Austria	.....	35	.....		28,540	14,228	21,538
France	122	124	.....				

Importers of Ceylon graphite and those who purchase it from the importers are required to furnish to the local representatives of the British Government a guaranty, drawn up in prescribed form, in which they agree not to sell "plumbago crucibles or plumbago in a form suitable (whether after refining or otherwise) for the manufacture of or for use as crucibles, foundry facings, or lubricants" to countries at war with Great Britain or to neutral countries, except "by shipments to the United Kingdom or France and reshipment from there, under license to be obtained for export therefrom."

The purpose of the guaranty is to prevent a mineral mined in a British colony and valuable in the manufacture of munitions of war from reaching the enemies of Great Britain. As, however, Ceylon graphite is not specifically mentioned, the guaranty virtually prohibits the exportation of graphite or graphite products, whatsoever the source of the graphite, to neutral countries by firms who handle even small quantities of Ceylon graphite. As several large American dealers handle graphite from many sources, this required guaranty has affected their established trade with neutral countries. This result is perhaps unavoidable in view of the difficulty in determining whether the graphite in a manufactured product came from Ceylon or from some other source. However, most American manufacturers of graphite products have been taxed to their full capacity to meet the demands of the domestic trade and of the allies, hence the effect of the restriction has not been as serious as might be supposed.

Many crucible makers are far behind in filling their orders because of the difficulty in obtaining sufficient graphite of crucible grade.

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Their difficulties have been further increased by the cutting off of the supply of clay from Klingenburg, Bavaria, which was used as a binder in graphite crucibles and was used, also, in pencil manufacture. None of this clay was imported in 1915, and the accumulated reserves are now practically exhausted. American crucible makers have conducted extensive tests to determine the suitability of certain American clays as substitutes, and many of them have husbanded their supplies of Klingenburg clay by mixing domestic clay with it. On the whole, the results obtained with the American clays have been fairly satisfactory, and it is to be hoped that when manufacturers have become familiar with the mixing and blending of the domestic clays a product will result that will be fully as satisfactory as that obtained from the Klingenburg clay. The most essential properties of a clay for use as crucibles are that it must be plastic, must not soften materially at 2,600 or 2,700° F., and must not spit or blow at high temperatures.

Madagascar graphite was imported in 1915 in considerably larger quantity than in 1914. The French Government has required guaranties essentially identical with those required by England for Ceylon graphite. The price c. i. f. New York increased from about 6 cents per pound at the beginning of the year to 11 or 12 cents at the end of the year. There was no notable change in the character of the graphite as compared with 1914; it averaged about 85 per cent graphitic carbon, was not subdivided into grades, and required finishing in this country before utilization. Most of it was consumed in the manufacture of crucibles. The scarcity of bottoms and the increasing demand in France for the Madagascar product makes it impossible at present for American firms to obtain as much of this graphite as they desire.

The price of Chosen (Korean) graphite early in 1915 was about $25 per ton c. i. f. New York. As a result of increased marine freight rates and the scarcity of bottoms, the price in New York rose to about $40 per ton at the end of the year and to $50 in March, 1916. Some of the material has come by rail from Seattle to the Atlantic seaboard. The Japanese Government has required no guaranties from consumers in regard to the utilization of this graphite. Graphite from Chosen is amorphous, analyzes 80 to 85 per cent graphitic carbon, and is used mainly for stove polishes, foundry facings, paint pigment, and the prevention of boiler scale.

The unsettled conditions in Mexico resulted in greatly reduced imports of Mexican graphite in 1915 as compared with 1914. The better grades of this graphite suitable for pencil manufacture normally bring 4 to 5 cents per pound c. i. f. New York. Late in 1915 the price rose to 5 to 6 cents per pound.

The better grades of American flake graphite sold in large lots at the mines in the eastern United States at from 6 to 8 cents per pound and in New York City at from 8 to 10 cents per pound. Small lots sold as high as 14 to 18 cents per pound in New York. Market conditions were reported by most producers to be very good.

Almost the entire Canadian production of graphite was imported into the United States, where it sold for about the same prices as the similar American flake graphite. The imports were much larger in 1915 than in 1914.

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REVIEW BY STATES AND TERRITORIES.

ALABAMA.

Four firms produced graphite in Alabama in 1915, the Alabama Graphite Co., the Quenelda Graphite Co., and the Jennings Graphite Co., all near Ashland, in Clay County, and the Flaketown Graphite Co., near Mountain Creek, in Chilton County. The Jennings Graphite Co. began operation late in 1914 and reported an important production in 1915. Its mine is 4 miles west of Lineville; its mill is equipped with an electrostatic separator.

Three new companies have recently begun operations near Ashland, but marketed no graphite during 1915. The Clay County Graphite Co. (Inc.) has a mine and a mill 2 miles north of Ashland. The mill began operation in March, 1916. The Standard Graphite Co., whose office is at Ashland, is developing a graphite property 8 miles west of that place. A mill is in process of erection and the property is expected to begin producing about the middle of 1916. The third company is known as the Southern Graphite Co.; its mine is about 3 miles northwest of Ashland and its mill is now (March, 1916) under construction.

ALASKA.

Some assessment and development work was done at the mine of the Alaska Graphite Co., near Teller, in the Port Clarence mining district, but no graphite was marketed during the year.

CALIFORNIA.

Several graphite properties in California were visited by the writer in March and April, 1915, and are briefly described below.

The graphite deposits of Los Angeles and San Diego counties resemble the characteristic deposits of New York, Pennsylvania, and Alabama in that the graphite occurs as crystalline "flakes" disseminated through a schist. The flakes in the California graphite schists are, however, much smaller than those in the eastern deposits, most of them not exceeding 0.25 millimeter in diameter. For this reason the problem of their concentration is somewhat different from that of the eastern deposits; furthermore, the concentrate would not be adapted for use in the manufacture of crucibles or other refractory products, for which a coarse flake is essential. On the other hand, the percentage of graphite in the California deposits appears to be nearly twice that of most of the eastern deposits of flake graphite. Another advantageous feature is the scarcity of mica, a mineral particularly difficult because of its flaky character to separate from flake graphite.

The California properties present, therefore, a number of favorable features. The fineness of the graphite undoubtedly renders difficult its complete separation from the gangue minerals, but there should be no great difficulty in obtaining a concentrate sufficiently rich in graphite to serve for foundry facings, boiler-scale preventive, and paint pigment, and at the same time in conducting experiments with a view to securing a purer product. For the uses mentioned above the graphite would have to compete with Chosen amorphous graphite, which before the outbreak of the European war could be bought at

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from $22.50 to $25 a ton in New York and at a still lower price on the Pacific coast.

SAN BERNARDINO COUNTY.

Several small graphite prospects occur in Eva Canyon, just north of Ontario and Upland. These are from half a mile to a mile from the mouth of the canyon in an area of crystalline schists and associated granite pegmatite. At the graphite prospects the schists are much decomposed, and in places there has been much slipping parallel or nearly parallel to their foliation. The greatest width of highly graphitic material noted was about 5 feet. The graphite is crystalline but very fine grained, and is so intimately mixed with silicates that it could probably not be separated from them economically in deposits so small. As the graphite layers are narrow and steeply inclined they would have to be mined by tunneling and stoping. The graphite and associated silicates, if ground without attempt at concentration, might command a local market for foundry facings, boiler compound, and paint pigment.

LOS ANGELES COUNTY.

A graphite property has been developed by the California Graphite Co., of Los Angeles, about 20 miles northeast of Saugus, near the junction of Bear and San Francisquito canyons. Saugus, on the Southern Pacific line, is the nearest railroad point, and the entire haul is downhill. The property was discoverd by G. A. Skinner in 1906; considerable development work has since been done and some experiments in concentration have been made. The workings are on steep mountain sides about 500 feet above the neighboring streams, which would furnish abundant water for wet concentration.

The graphite occurs disseminated in very small flakes through a schist which is so much decomposed near the surface that it can be excavated without blasting and is easily crushed preparatory to concentration; at greater depths more firmness in the schist and greater difficulty in crushing are to be expected.

Microscopic study of samples from Prince No. 1 and Prince No. 4 claims show that nearly all the graphite is in flakes 0.25 millimeter or less in diameter, but at the head of the wire tram of Prince No. 1 claim schist carrying graphite flakes as much as 1 millimeter in diameter was noted. The principal mineral of the graphite schist is the aluminum silicate, sillimanite (specific gravity, 3.24); other minerals in approximate order of abundance are quartz, feldspar, and very small quantities of pyrite. Determinations were made in the Survey laboratory of the percentage of graphite in three samples collected by the writer from this property, with the following results:

Graphite in graphite schist from Los Angeles County, Cal., 1915.

	Percentage of graphite.
Composite sample of graphitic schist from many different localities on Prince No. 1 claim	7.29
Composite sample taken at intervals of about 1 foot across 50 feet of graphitic schist exposed in crosscuts in tunnel on Prince No. 4 claim	12.00
Sample of richest type of graphite schist from same tunnel	17.48

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The development work on Prince No. 1 claim includes a shaft 64 feet deep and a tunnel 108 feet long, all in the graphitic schist. The graphitic schist outcropping on this claim forms a band from 8 to 20 feet in width that has been traced for more than a quarter of a mile along the north side of San Francisquito Valley. The graphitic schist is locally much sheared and in places faulted into contact with altered granite.

The next most extensive development has been on Prince No. 4 claim, nearly half a mile east of Prince No. 1 claim. Here there is a tunnel about 200 feet in length parallel to the schist foliation, which strikes northeast and is nearly vertical. Crosscuts aggregating 100 feet in length expose fully 70 feet of schist, measured at right angles to the foliation, of which at least 50 feet is highly graphitic. A biotite granite, somewhat banded or gneissic in texture, is associated with the graphitic schist. Large samples from Prince No. 4 claim sent to Germany for experimental treatment are said to have concentrated 6 into 1, yielding a concentrate of lubricating grade.

SAN DIEGO COUNTY.

The Leebrick graphite mine is situated in the Mason Valley about 3 miles east of the head of Oriflamme Creek, sec. 10, T. 14 S., R. 5 E. The altitude of the mine is between 2,600 and 2,700 feet. It is about 80 miles distant by road from San Diego and about 50 miles from Foster, the terminus of the San Diego & Southeastern Railway. The workings consist of a short tunnel and several small open pits. Only development work has been done.

The deposit is a band of graphitic schist with a maximum width of 80 feet, which is traceable for about 400 feet. At the south end of its exposure this schist strikes about N. 85° W., but farther northwest the strike shifts to N. 60° W. The average dip is about 65° NE. The graphitic schist terminates on the southeast just below the main tunnel at a small gulch, which probably follows a fault. Beyond this, in line with the strike of the graphitic schist, only granite gneiss and pegmatite occur.

The percentage by weight of graphite in a composite sample of graphitic schist collected by the writer from a large number of places in this graphite deposit was determined in the Survey laboratory as 11.9 per cent. Microscopic study of the sample showed that most of the graphite flakes were less than 0.2 millimeter in diameter, and practically all were less than 0.5 millimeter. The associated minerals are quartz, brown hornblende, and a little pyrite.

The Seyer graphite property lies about 2 miles north of the Leebrick mine and has been opened by W. B. Seyer, of Julian, Cal. The property was not visited by the writer, but according to Mr. Seyer there are two graphitic bands 4 and 12 feet wide, respectively. Most of the graphite forms minute flakes a small fraction of a millimeter across in a fine-grained schist, but scattered through this schist are rounded nodules of graphite as large as a pea. The nodules are nearly pure graphite in flakes measuring as much as 0.5 millimeter in diameter; their origin was not determined. An analysis by the Survey of a sample of graphitic schist from this property furnished by Mr. Seyer showed 16.2 per cent graphite.

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COLORADO.

The mine of the Federal Graphite Co., near Turret, in Chaffee County, was idle in 1914 and 1915.

In 1914 Mr. Dexter T. Sapp, of Gunnison, Colo., reported the discovery of a vein of graphite in Gunnison County. The property is undeveloped. A small sample sent to the Survey was a hard amorphous graphite.

MICHIGAN.

The mine of the Detroit Graphite Co., near L'Anse, in Baraga County, Mich., has not been operated since 1913, enough graphite having been mined to fill the company's requirements to the present time. The company plans to resume mining during the summer of 1916 and to take out sufficient material to supply its needs for several years.

The plant of the Northern Graphite Works, also near L'Anse, was not, so far as could be learned, in operation in 1915

MONTANA.

Graphite mining was continued during 1915 at the mine of the Crystal Graphite Co., near Dillon, Mont., and important shipments were made to eastern markets. The appearance of the deposit as development has progressed is reported to be encouraging.

NEVADA.

The property of the Black Lead Mining Co., of Carson, Nev., was visited by the writer in the fall of 1915. It is about 4 miles by road southwest of Carson City, the haul from the mine to town being downhill all the way over a fair road. The claims are in secs. 25 and 26, T. 15 N., R. 19 E. Mount Diablo meridian; they have been developed mainly by W. H. Chedic, of Carson City. Small amounts of graphitic rock have been mined here for a number of years, most of it from an open pit near the line between secs. 25 and 26. The material exposed in this pit is a black graphitic shale which is considerably distorted but appears to have a general trend west and is traceable for several hundred feet west of the pit. This shale has been intruded, both south and north of the open pit, by a nearly black rock of basaltic appearance; the dike just south of the pit is at least 50 feet wide. The basaltic rock has in turn been intruded by several small dikes of pegmatitic granite and considerable masses of granite were noted a short distance east of the mine near the road to Carson. The proximity of the basaltic rock to the graphitic shale suggests that it was through the heat attending its intrusion in a molten condition into the black shale that a part, at least, of the carbon in the shale was converted into the graphitic state. The neighboring masses of granite may, however, have been in part responsible for the change. In sec. 26, a quarter of a mile or so northwest of the open pit referred to above, graphitic shale has been developed in a tunnel 172 feet long trending S. 8° E. The small open pit at the mouth of the tunnel and the northern part of the tunnel itself expose a width of about 100 feet of graphitic rock entirely similar to that at the open pit just described. The remainder of the tunnel is in the basalt. Both basalt and

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graphitic shale are cut by small dikes of pegmatitic granite. The intrusion of the granitic rock was subsequent to the development of jointing in the basalt, for in places the dikes follow joints. The graphitic shale has been traced in the surface for about a quarter of a mile west and for the same distance east of this tunnel.

A composite sample of the graphitic shale from 20 different places across the face of the larger open pit was analyzed in the Survey laboratory and was found to contain 49 per cent of carbon.

The graphite particles in this material are extremely fine, so that it is to be classed commercially as amorphous graphite. Separation of the graphite from its associated minerals is not economically feasible; but the material after fine grinding is suitable for use as paint pigment and as foundry facing, and most of that mined to date has been utilized in the manufacture of graphite paints in a small mill at Carson City, operated periodically by this company.

Small amounts of graphitic shale have also been found in sec. 25 on claims of Wm. W. Coleman, of Carson City.

NEW YORK.

The mine of the Joseph Dixon Crucible Co., at Graphite, in Warren County, N. Y., was operated continuously in 1915. The only new development was the resumption of mining at one of the old workings, the so-called Summer pit, which has not been worked in recent years. At the plant of this company at Jersey City, N. J., two new crucible kilns are being erected, which will increase the capacity of the crucible factory about 25 per cent. The pencil factory has recently been enlarged and a large annex has also been erected, which will permit of further expansion but which for the present will be used only for storage and shipping. Development work was continued by William Faxon on his property adjoining the Dixon mine, but no graphite was marketed.

The Graphite Products Corporation, with mines in the towns of Wilton and Greenfield, in Saratoga County, increased its production materially during 1915 and reports the erection of a new mill, which will about double its capacity.

The Popes Mills Graphite Co., with plant at Popes Mills, in St. Lawrence County, reported a small production in 1915.

J. J. Steacy, of Redwood, N. Y., under date of January 7, 1916, reported the discovery of a deposit of flake graphite in the town of Alexandria, in the northern part of Jefferson County. The deposit lies about 3 miles from Redwood, on the farm of John Stine, and borders Butterfield Lake. A sample forwarded to the Survey is a crystalline limestone carrying flakes of crystalline graphite, most of them between 1 and 2 millimeters in diameter. These flakes probably constitute about 5 per cent by weight of the rock. The material is similar in a general way to that formerly worked by the Crown Point Graphite Co., in Essex County, N. Y.

NORTH CAROLINA.

A few tons of graphitic rock were mined in 1915 by the Southern Graphite Co., at Barretts Mountain, near Taylorsville, in Alexander County, but no material from this property has been marketed.

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The principal graphite deposits of the State have been briefly described by the North Carolina Geological Survey,[1] and copies of the report may be obtained by addressing the State geologist at Chapel Hill, N. C. According to this report the graphite at Barretts Mountain occurs as a constituent of dikes of coarse granite (pegmatite), which vary from a few inches to 5 feet in width. In these dikes the graphite forms nodules from a fraction of an inch to 6 or more inches in width. The quantity of graphite in the dikes will not average over 25 per cent, but is said to be in places as high as 50 or 60 per cent. The nodules are nearly pure graphite.

PENNSYLVANIA.

Two firms engaged in mining graphite in Chester County, Pa., during 1915; these were the Rock Graphite Mining & Manufacturing Co., with mine and mill near Chester Springs, and the Graphite Products Co. (John H. Lilly in charge), which operated the property near Byers formerly worked by the Pennsylvania Graphite Co. The Chester Graphite Co., near Chester Springs, was engaged in refining graphite from various sources, but conducted no mining operation.

The property owned by Pettinos Bros., near Byers, was leased in April, 1915, to the Tonkin Graphite Co. The mill in process of erection by this company is not yet completed and no production was reported for 1915.

RHODE ISLAND.

Amorphous graphite was mined at Fenner's ledge on the outskirts of Providence, R. I., and sold for foundry facings. Six analyses of this material show a graphite content ranging from 25 to 64 per cent. In a report published in 1915 Ashley[2] shows that the graphite has been formed through the alteration of beds of impure coal. He says:

> Though all the anthracite contains more or less graphite, portions of the beds have been changed entirely to what appears to be graphite. Such a bed at Fenner's ledge is being mined at present in an open cut by Mr. Fenner and sold for foundry facings, for which it appears to be well adapted after the proper preparation. At the old Gross mine, to the south, an attempt was made to prepare the graphite for market. Buildings were erected and machinery installed. The graphite was crushed and screened, using expensive brass sieves. The process adopted did not prove successful, apparently owing to the difficulty of separating the fine quartz.
>
> Graphite has also been mined at Bridgeton, Valley Falls, and Tiverton, at the first and last places from open cuts, but at Valley Falls the workings were extended underground. The material was used for foundry facings and some of it for furnace linings.

VIRGINIA.

Development work was done in 1915 under the direction of C. H. Hurkamp, of Fredericksburg, at the Naylor graphite property, in the northern part of Albemarle County, Va. A new shaft has been sunk and encouraging showings of graphite are reported.

Prospecting for graphite has been carried on 3½ miles from Front Royal, in Warren County, on the property of J. H. Thompson, of Front Royal. A sample submitted to the writer is a schist in which graphite occurs in flakes, most of them under 1 millimeter (four one-

[1] Pratt, J. H., The mining industry in North Carolina during 1901: North Carolina Geol. Survey Econ. Paper 6, pp. 69–72, 1902.
[2] Ashley, G. H., Rhode Island coal: U. S. Geol. Survey Bull. 615, 1915.

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hundredths of an inch) in diameter. Associated minerals are mostly quartz, feldspar, and a little brown mica. A clean concentrate obtained from this material would be too fine grained for use in the manufacture of crucibles and other refractory products, but would be suitable for most other uses of graphite.

WASHINGTON.

Some development work has been done recently on graphite properties on the east slope of the Cascade Range in Chelan County, Wash. These deposits are several miles west of Nason station, on the Great Northern Railway near the confluence of Nason and Whitepine creeks. From the descriptions received there seem to be in this locality several bodies of schists carrying a small percentage of graphite, and in the schists occur "veins" or lenses, from a fraction of an inch to 18 inches wide, of material carrying a much larger percentage of graphite.

From the samples submitted most of the graphite, both of the "veins" and of the larger bodies, appears to be very finely crystalline, most of the flakes being considerably less than 0.5 millimeter in diameter. The separation of graphite of this fineness from its gangue minerals would involve serious though perhaps not insuperable mechanical difficulties, but simple pulverizing of the richer material would yield a product well adapted for use as paint pigment, foundry facings, boiler scale preventives, and possibly as stove polish. John Maloney, of Skykomish, is interested in the development of this property.

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POTASH SALTS.

By W. C. PHALEN.

DOMESTIC CONDITIONS.

The year 1915 was an epoch making one in the domestic potash industry There was produced in this country that year soluble potash salts valued at $342,000. Quantities are not given for the reason that the product sold came from diverse sources and contained varying proportions of potash. Though this figure for value is of interest as a small beginning in the domestic potash-salts industry, it is practically of no importance in comparison with the total needs of the country, as the quantity it represents is consumed in less than a week in normal times.

The price of potash salts has increased greatly since the domestic scarcity began to be felt. From a normal price of $35 to $40 a ton for high-grade agricultural salts, prices have advanced until in the spring of 1916 chloride and sulphate were quoted at ten times those figures or more. In April, 1916, chloride was nominally quoted at quoted at $425 a ton and sulphate from $350 to $400 a ton.

Experimental work on the production of potash salts from different sources was most active during 1915, and in some places experiment has passed into active construction of works for the production of soluble potash salts. By-product potash from cement manufacture has become a reality at Riverside, Cal. Potassium sulphate from alunite was first placed on the market late in October, 1915, at Marysvale, Utah. An important production of potash salts is announced from Jesse Lake, near Hoffland, western Nebraska. Some potash was marketed in the form of dried kelp, which, however, must be considered of organic, rather than mineral origin. Without much doubt, potash salts were produced in small quantity from feldspar or other silicate rocks and incorporated into mixed fertilizers without intermediate refinement. The value of this material can not be stated, nor is it included in the figure given, and the quantity is thought to have been small. The fertilizer manufacturers in general are not optimistic with reference to the silicates as a source of potash salts because only low-grade material can be produced and, further, because any plant established for this production would most likely have to be scrapped at the close of the present war in Europe.

Active operations are in progress in California at Searles Lake and at Keeler, on the shore of Owens Lake, and the by-product bittern at the solar evaporation plants on San Francisco Bay has also received some attention.

In Utah, near Great Salt Lake, as is reported, one company is erecting a plant and another plant will soon be begun at the south

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end of the lake. An additional plant is also planned for Marysvale for work on alunite.

Manufacturers of Portland cement having had their attention directed to a possible revenue from by-product potash, will not be slow to investigate their raw material thoroughly. Already the Security Cement & Lime Co., near Hagerstown, Md., is reported to be installing a plant for recovering potash salts.

Great activity has been manifested in experiments on other raw materials, such as feldspar, leucite, sericite, and greensand, but the great expense involved in obtaining potash salts from these sources, the uncertainties with which manufacturers will be confronted, and the keen German competition which must be met at the close of the European war are potent factors in discouraging any considerable undertakings.

IMPORTS.[a]

POTASH SALTS.

The imports of refined potash salts (all from Germany), which include the 80 per cent chloride used in agriculture, were about one-fourth in 1915 what they were in 1913, the last normal year, and the imports of kainite and manure salts were about 3 per cent of those in 1913. All the imports of potash salts taken together amounted in 1915 to about one-tenth of recent imports under normal conditions. The imports of fertilizers given also in the chapter on phosphate rock are shown here for comparison.

Potash salts imported for consumption into the United States, 1912–1915.

	1912		1913	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Potash:				
Carbonate of, crude	7,625,382	$234,868	9,715,878	$272,973
Caustic, not including refined	9,690,494	370,506	[b] 8,648,753	342,056
Cyanide of	726,659	109,434	1,470,987	216,844
Chloride of	482,529,396	7,239,121	475,261,595	7,075,765
Nitrate of, saltpeter, crude	6,511,208	202,899	9,652,366	261,078
Sulphate of	98,237,150	1,783,846	88,696,193	1,677,429
All other	16,858,875	761,611	19,067,144	969,595
	622,179,164	10,692,285	612,514,916	10,805,720

	1914		1915	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Potash:				
Carbonate of, crude	9,326,899	$265,158	5,386,719	$191,621
Caustic, not including refined	[b] 7,284,176	285,739	2,032,319	100,035
Cyanide of	417,139	59,278	871,871	134,123
Chloride of	371,521,920	5,745,385	129,339,840	2,396,606
Nitrate of, saltpeter, crude	2,230,528	74,869	6,855	400
Sulphate of	80,447,360	1,557,224	25,415,040	664,484
All other	14,590,437	756,320	7,502,806	377,955
	485,818,459	8,743,973	170,555,450	3,765,224

[a] Figures of imports furnished by Bur. For. and Dom. Commerce, U. S. Dept. Commerce.
[b] Including refined.

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FERTILIZERS.

Fertilizers imported for consumption into the United States, 1912–1915.

Fertiliser.	1912		1913	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Apatite	100	$1,400	2,962	$22,471
Bone dust or animal carbon, and bone ash, fit only for fertilizing purposes	117,717	878,686	35,012	851,136
Calcium cyanamid or lime nitrogen	9,311	493,519	26,729	1,410,248
Guano	19,128	329,624	16,674	518,429
Kainite	511,976	2,398,362	465,336	2,201,730
Manure salts, including double manure salts	171,757	1,797,057	223,687	2,245,509
Phosphates, crude	28,821	231,255	17,121	124,815
Slag, basic, ground or unground	12,596	114,300	13,186	130,455
All other substances used only for manure	127,932	2,660,887	154,729	3,314,460
	999,338	8,893,090	955,436	10,819,253

Fertiliser.	1914		1915	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Apatite	20	$300	.....	.....
Bone dust or animal carbon, and bone ash, fit only for fertilizing purposes	36,000	892,529	21,538	$543,243
Calcium cyanamid or lime nitrogen	21,793	1,119,785	30,043	1,322,195
Guano	25,335	761,562	9,874	220,768
Kainite	313,898	1,551,115	6,674	95,440
Manure salts, including double manure salts	168,969	1,846,475	13,753	200,584
Phosphates, crude	15,079	136,526	5,359	50,606
Slag, basic, ground or unground	9,199	105,272	76	1,343
All other substances used only for manure	171,603	3,507,875	72,848	1,535,860
	761,896	9,921,439	160,165	3,970,039

MATERIALS OF THE DOMESTIC FERTILIZER INDUSTRY.

Materials entering largely into the fertilizer industry in the United States, 1912–1915.

	1912		1913	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Imports: [a]				
Fertilizers	999,338	$8,893,090	955,436	$10,819,253
Potassium chloride	215,415	7,229,121	212,170	7,075,745
Potassium sulphate	43,856	1,783,846	39,597	1,677,429
Sodium nitrate	486,779	16,544,511	612,861	21,630,811
Domestic phosphate rock	2,973,332	11,675,774	3,111,221	11,796,231
	.....	46,126,342	.....	52,999,469

	1914		1915	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Imports: [a]				
Fertilizers	761,896	$9,921,439	160,165	$3,970,039
Potassium chloride	165,858	5,745,385	57,741	2,296,006
Potassium sulphate	35,914	1,557,224	11,346	664,484
Sodium nitrate	545,730	15,204,539	770,628	22,844,746
Domestic phosphate rock	2,734,043	9,608,041	1,835,667	5,413,449
	.....	42,036,628	.....	35,189,324

[a] Imports for consumption.

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WORK OF THE GEOLOGICAL SURVEY ON POTASH SALTS.

SCOPE OF THE WORK.

The work of the United States Geological Survey on the general subject of potash salts in 1915 included investigations in both the field and the laboratory. The work in the field included (*a*) stratigraphic investigation in the "Red Beds" region of New Mexico and adjacent States and continued study of the history of certain basins of evaporated lakes in Nevada, (*b*) drilling operations in Texas and Nevada, (*c*) examination of reported occurrences or prospects of potash salts and nitrates, (*d*) examination of alunite deposits, and (*e*) examination of greensand marl deposits. In the laboratory research work was done on the evaporation of bitterns and on certain of the potash-bearing silicate rocks. Many specimens that have been sent to the Survey by citizens from different parts of the country have been tested for potash salts and nitrates.

FIELD WORK.

The stratigraphic investigations of the "Red Beds" region of New Mexico and adjacent States were conducted by N. H. Darton, of the United States Geological Survey, who is now preparing a report on his work.

One result of the investigations of the "Red Beds" by Mr. Darton has been the selection of a site for an exploratory boring near Amarillo, in northwestern Texas, where drilling was begun in December. Buried salt deposits of great thickness are known to occur in this part of Texas, and the site chosen for the Survey test is near the locality at which potash-bearing crystals of red salt were obtained and studied by Dr. J. A. Udden,[1] of the Bureau of Economic Geology and Technology of the University of Texas. This boring should help to determine definitely whether or not potash salts are associated with the common salt in quantities large enough to be of commercial importance at this locality.

During the summer of 1915 four deep wells were drilled in the Smoke Creek Desert, Nevada, in search of buried saline deposits in the desert basin region. The results of this work were negative so far as the discovery of concentrated deposits of potash salts were concerned, but geologic information of value was obtained.

Besides this work with the drill a general investigation of recent developments and important occurrences of potash salts and nitrates has been made in several Western States. Many minor occurrences of potash salts and nitrates have been examined, but none have proved to be of any particular importance.

Some of the results of the Survey's alunite investigations, which have been obtained since the publication of this report for 1914, are briefly reviewed herein. Some recent analyses of the greensands of New Jersey are also given.

LABORATORY WORK.

Besides the field work by several geologists, some experimental work in the chemical laboratory of the United States Geological Sur-

[1] Udden, J. A., Potash in the Texas Permian: Texas Univ. Bull. 17, Mar. 20, 1915.

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vey has been carried on by W. B. Hicks on the evaporation of natural and artifical brines containing potash and by R. C. Wells on the extraction of potash from the wyomingite of the Leucite Hills in Wyoming. Hicks's results are referred to in the bibliography at the end of this report, and a preliminary statement of the work by Wells appears in the Survey's Professional Paper 98–D.

WORK OF THE BUREAU OF SOILS.[1]

The work of the Bureau of Soils in the investigation of potash salts in 1915 has been confined largely to continuation of its earlier work on the kelps of the Pacific coast. The bureau intends to continue its efforts to establish a potash-from-kelp industry on the western coast, but the exact lines of its procedure have not been fully determined and no details can be given out at the present time.

The bureau is continuing investigations on the possible utilization of feldspar as a source of potash, and it has just completed a plant at Arlington, Va., in which a number of processes will be tried out, but not enough information has yet been obtained to form any very definite conclusion.

POTASH IN TEXAS.

The report by J. A. Udden,[2] already referred to, contains data and general conclusions which have resulted from the examination of drill records, brines, and cuttings from 18 borings in the area of the Permian "Red Beds" of northwestern Texas and the adjoining part of New Mexico.

Potash was first found in the brine of the deep well at Spur, in Dickens County, Tex. This brine, which was tested as a result of the examination of the log and cuttings by Dr. Udden, then studying these materials under the auspices of the United States Geological Survey, was believed to have come from a depth of about 2,200 feet in the well.

Potash-bearing salts were found in making some tests for oil or potable waters on material from two wells in Texas, the Boden well, Potter County, and the Miller well, Randall County; and, it is believed, also from the Adrian boring, Oldham County. The Potter County well is 23 miles northwest of Amarillo, and the Randall County well is 16 miles southwest of this city. The air-line distance between the two wells is about 30 miles.

The largest showing of potash found in the Boden well, expressed as percentage of the soluble portion, was 9.23 per cent. The material yielding this quantity came from a depth of 875 to 925 feet. The portion analyzed was 87.24 per cent of the original sample.

The maximum showing of potash from the Miller well in Randall County was 10.50 per cent of the soluble portion, the sample containing the potash coming from a depth of 1,700 feet. The total soluble portion was 51.72 per cent of the original sample. Both the samples tested were, however, minute grains picked from portions of the cuttings which had been saved during the drilling of these wells, and it was impossible to determine at the time of their identification

[1] Statement to the Geological Survey by Milton Whitney, Chief of the Bureau of Soils of the U. S. Department of Agriculture.
[2] Op. cit.

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as potash whether these grains came from deposits of sufficient size to be of practical value or whether they are of mineralogic interest only.

Udden believes as a result of the finds made that the existence of potash salts is rendered so probable as—

to warrant the beginning of explorations to settle the question of its presence or absence. From the evidence now in hand it would appear most profitable, perhaps, to make the first test in the vicinity of the localities where potash salts have already been discovered. The data presented show that extensive salt beds underlie not only the greater part of the Panhandle, but that they extend south to Upton County and west into New Mexico.

He further concludes that—

the territory which appears from our present knowledge to give most promise is along the supposed axis of the basin, southward and a little westward from Boden, the Miller ranch, and Adrian.

From the explorations already made, it is evident that tests should extend to the greatest depth at which it may be considered profitable to work, say 2,000 feet. The "red salt" horizon in the Miller and the Boden borings will lie, it is believed, under most of the territory indicated, between 2,000 and 2,400 feet above sea level, or from 800 to 1,700 feet below the surface.

SEARLES LAKE, CALIFORNIA.

The American Trona Corporation was busy throughout 1915 with its projects for the manufacture of potash salts, both at Trona (Searles Lake) and at San Pedro, Cal. The company established in the fall of 1915 an experimental plant in New York City, consisting of evaporators, carbonators, and centrifugal and auxiliary machinery, for the purpose of experimenting on a large scale with the bitterns of Searles Lake. From Trona there were shipped to the experimental plant 60,000 gallons of bittern for a demonstration of their process on a large scale. In the concluding test made at the plant more than 600 gallons of bittern were used. The specific gravity of the Searles Lake bittern is 1.2974; hence, a gallon of the bittern weighs 10.8 pounds; and the quantity experimented with was therefore in excess of three short tons.

In the process of making a clean separation of the potassium chloride from the borax contained in the bittern there are two phases on which it is the intention to obtain patents.

In working with the Searles Lake bitterns artificial evaporation has to be resorted to but in a manner different from the methods used in salt or sugar works. One of the patents will describe the use of artificial evaporation in an apparatus very similar to the one used for producing common salt but duly modified to avoid losses in potassium chloride.

The company is erecting two plants—one at Searles Lake, or Trona, as the place is now called, and the other at San Pedro, near Los Angeles. The plant at Trona will produce the concentrated salts and these will be refined at the San Pedro plant. Barring accidents, the company expects to have potash and borax ready for market early in 1916, and already many applications for the potash salts have been received.

The product will at first probably contain an excess of 20 per cent borax, but as soon as the refinery at San Pedro is in operation the borax will be separated from the potash salts. Later on, when the first refinery unit is in running order, it is proposed to separate sodium

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carbonate and sodium sulphate, if any use can be found for the latter salts.

The evaporator house at Trona is a steel structure 109 feet high, and the boilers will have 2,000 horsepower. The spray pond for cooling condensing water is built entirely of reinforced concrete. A reinforced concrete chimney, 150 feet high and 9 feet in diameter in the clear on top, tanks, and crystallizing vats, triple-effect evaporators, and a traveling crane for the evaporator building are features of the equipment.

The erection of the refinery at San Pedro is also progressing rapidly. As soon as the first unit of this plant is in running order the company proposes to install a second unit and to increase the works.

The corporation had invested up to November 30, 1915, nearly $2,000,000 in this enterprise. The standard gage railroad, 30 miles long, connecting the deposit with the main line of the Southern Pacific Railroad at Searles, cost more than $600,000. The remainder has been spent on chemical investigations, on the experimental chemical plants, the assessment work on its claims required by law, and on other expenses incidental to construction at the deposit such as housing, fresh-water system, and so on.

It is estimated that the plants at Trona and San Pedro, when completed, will cost about $700,000, of which more than $200,000 already spent is included in the total expenditure of $2,000,000 up to November 30, 1915. Before earnings are available the expenditures will doubtless exceed $2,500,000. Future additions to the works will probably increase the total investment to more than $4,000,000.[1]

OWENS LAKE, CALIFORNIA.

Owens Lake, Inyo County, Cal., is the only existing remnant of the former lake system which comprised bodies of water in Owens Valley, Indian Wells Valley, Salt Wells Valley, the present Searles Lake, so-called, and in Panamint Valley. The lake itself is a large shallow body of water in the extreme southern part of Owens Valley and, according to the survey of February, 1913, has an area of 97.2 square miles and a maximum depth of water of 29.6 feet. The water, which is a dense brine, contains common salt, soda, borax, and other salines in solution. The lake has no outlet, and the volume of water in it depends upon the balance between evaporation and inflow.

In the processes that have formerly been used for extracting soda from the lake water the mother liquors that result from the crystallization of this compound and that contain considerable of the carbonate are returned to the lake, including the sodium chloride, borax, sodium sulphate, as well as all the potash salts. The soda which has been made from the lake waters near the little town of Keeler crystallizes out in the form of trona ($Na_2CO_3.NaHCO_3.10H_2O$); but in cold weather part of it is found as $Na_2CO_3.10H_2O$, which may include some sodium sulphate if care is not taken. The carbonate is converted by furnacing into the anhydrous carbonate (Na_2CO_3) which contains a minimum of 95 per cent soda.

[1] The figures cited were taken from a statement and memorandum by J. A. Brown given to the Senate Committee on Public Lands, February 2, 1916, and the general developments were noted in correspondence with officials of the company.

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The chemical composition of the water of Owens Lake is well known from several analyses, which agree fairly well with the exception of the determinations of boric acid. A recent analysis made by W. B. Hicks in the laboratory of the United States Geological Survey is as follows:

Composition of salts dissolved in water of Owens Lake, Cal.

[Sample collected by Hoyt S. Gale below water surface.]

	Percentage of anhydrous residue.	Recalculated to Na_2CO_3, free basis.		Percentage of anhydrous residue.	Recalculated to Na_2CO_3, free basis.
Cl	25.56	42.05	Mg		
SO_4	9.96	16.36	SiO_2	0.21	0.35
CO_3	22.18		Al_2O_3		
PO_4			Fe_2O_3		
B_4O_7	1.92	3.15	As_2O_3		
NO_3					
Na	38.07	34.64		100.00	100.00
K	2.10	3.45	Total anhydrous salts, percentage of original sample...	10.95	
Li					
Ca					

Specific gravity of the solution at 21° C., referred to water at 20° C., 1.0977.

The potassium in the analysis given in the first column corresponds to 4 per cent potassium chloride, the form in which doubtless the greater part of the potash in the lake water occurs. After the removal of the sodium carbonate, the saline material has the composition indicated in the second column in the table above, and the potassium in the recalculated analysis corresponds to 6.56 per cent potassium chloride.

On the assumption that the lake level in October, 1912, was about 3,577 feet in altitude at the time the sample, the analysis of which is given above, was collected, a volume of approximately 1,000,000 acre-feet of water is indicated. A calculation from this quantity and the analysis quoted shows the lake waters to contain in round numbers as follows:

Approximate total content of chlorine, sodium, potassium, etc., in the water of Owens Lake, Cal.

	Short tons.
Chlorine	40,000,000
Sodium	60,000,000
Potassium	3,360,000
Anhydrous boric acid (B_2O_3)	3,070,000
Total anhydrous salts	160,000,000

These figures are considerably in excess of the estimates made by O. Loew,[1] who calculated 5,000,000 tons of potassium sulphate, but Loew's figures for volume were very moderate even for the data which he then had, and the estimates by Gale[2] given above have the advantage of much more exact volume computations.

The estimate that more than 3,000,000 tons of potassium is dissolved in the Owens Lake water is doubtless not far from correct, and, though very much lower in potash content than the brine of

[1] U. S. Geog. Surveys W. 100th Mer. Ann. Rept. for 1876, p. 190.
[2] Gale, H. S., Salines in the Owens, Searles, and Panamint basins, southeastern California: U. S. Geol Survey Bull. 580, pp. 259–260, 1915.

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Searles Lake, these waters may be considered among the important sources of potash salts.

The method of procedure at Owens Lake whereby the soda and potash salts will be recovered has been worked out by Carl Elschner by a process of fractional crystallization without the employment of artificial heat and the work has been undertaken by the Inyo Development Co., E. B. Davis, general manager. Vats were constructed for the solar evaporation of the waters in May, 1915, and late in September the first potash salts were made. The coming of cold weather made it impossible to work up all the concentrated potash liquors without the employment of artificial evaporation. The quantity of potash salts obtained to date, therefore, has been small and not more than a carload has been sold, but during the coming season it is expected that several thousand tons will be made and the experimental plant will be much enlarged.

GREAT SALT LAKE, UTAH.

The Utah Chemical Co. is erecting a plant on the shore of Great Salt Lake for extracting potash salts from the bitterns obtained as a by-product in the manufacture of solar salt by the Inland Crystal Salt Co. Building operations began about the middle of February, 1916, and according to Mr. L. C. Haskell, the manager of the company, production should soon begin. The plant is entirely experimental, and at this time the quantity of potash which will be produced is unknown. Magnesium chloride will also probably be produced.

It has been reported that the Diamond Match Co. will also extract potash salts from the water of Great Salt Lake. The plant which the company proposes to erect will be located at Grants, on the Western Pacific Railway, about 30 miles west of Salt Lake City, and near the south end of the lake.

PROCESS OF EXTRACTING POTASH SALTS FROM BITTERN.

Joseph A. Bradburn,[1] outlines a method for obtaining potassium chloride from brines or bitterns containing a combination of salts, such as sodium chloride, potassium chloride, sodium sulphate, magnesium chloride, and calcium sulphate. The water of Great Salt Lake is taken as a type.

The method consists in subjecting the bittern to a low temperature, as a result of which the greater portion of the sodium sulphate crystallizes out and is removed. The resulting liquor is evaporated and the greater part of the sodium chloride separates and is removed. Next, magnesium chloride is added to the mother liquor and the solution is subjected to evaporation in the hot. This results in the separation of the remaining sodium chloride, which is removed. The hot solution is cooled, as a result of which crude potassium chloride separates. The potassium chloride may be filtered off and washed. It forms a product 80 per cent pure, the remaining 20 per cent being composed of other salts. The mother liquor resulting from the separation of the potassium chloride is largely a solution of magnesium chloride, which may be used over again in the process.

[1] U. S. patent 1156388, dated Oct. 12, 1915.

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EXPERIMENTAL WORK ON RESIDUAL BITTERNS FROM CALIFORNIA SALT WORKS.

Edward B. Durham, of Berkeley, Cal., has experimented with the residual bitterns from the manufacture of salt on San Francisco Bay. He has separated the magnesium carbonate from these bitterns by using sal soda, and it appears from his work that this may profitably be done. His process leaves, however, the valuable potassium salts still to be recovered.

As the price of magnesium chloride has been high on the Pacific coast during 1915, separation of this chloride as well as magnesium sulphate from these bitterns has also been considered. The artificial carnallite produced in the process would of course be utilized.

POTASH SALTS FROM NEBRASKA LAKES.[1]

LOCATION.

The plant of the Potash Products Co., of Omaha, Nebr., was established in the spring of 1915 at Hoffland, a station 13 miles east of Alliance, in northwestern Nebraska, to obtain potash salts from the water of an alkaline lake in that region. Potash salts have been produced in this locality for about half the year.

There are many alkaline lakes in the Sand Hills region of Nebraska, which comprises 8,000 square miles covered by Tertiary and Pleistocene sediments. Niobrara and North Platte rivers form, respectively, the northern and the southern boundaries of the lake region; the western boundary is a line passing southwestward just east of Alliance, and the eastern boundary is a line passing southward through O'Neill. There are several small outlying areas.

The lake whose waters are being evaporated (Jesse Lake) is in the extreme western part of this district. Transportation facilities are good, as Alliance is on the Omaha-Seattle line connecting with the Chicago & Northwestern and on the Denver-Billings line of the Chicago, Burlington & Quincy Railroad, connecting with the Union Pacific.

Scattered among the Sand Hills are a great many depressions that have no outlet, formed apparently by wind erosion. They are locally known as "sinks" and many of them contain one or more lakes, the water in which is retained by an impervious layer of hard pan or mud. The large and deep bodies of water are only slightly alkaline, but some of the smaller ones are comparatively rich in salts.

COMPOSITION OF WATER.

Twenty-four analyses, some of them made by the United States Geological Survey and some by J. H. Show, of the Potash Products Co., indicate that the percentage of dry salts (salinity) in the lake waters may run as high as 13.55 per cent, and the content of potassa in the dry salts of the 24 samples ranges from 8.96 to 35.85 per cent. No samples containing less than 2 per cent potassa are included in the 24 analyzed. Another set of analyses by J. H. Show shows that the brines carry essentially potassium and sodium carbonates and sulphates, with the soda usually in excess. Chlorides, except in the waters of a few lakes, are in minor quantities.

[1] Abstracted from a paper by Victor Ziegler entitled, The potash deposits of the Sand Hills region of northwestern Nebraska: Colorado School of Mines Quart., vol. 10, No. 3, pp. 6–26, October, 1915.

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The samples collected by the United States Geological Survey in the search for potash a few years ago comprise muds, brines, and saline crusts. In addition to the samples included in the tables below 94 others were collected; but as they contained less than 3 per cent of dissolved material (87 of them contained less than 2 per cent) further analysis of their potassium content was not made. The following analyses were published by the Survey in 1914.[1]

Potash analyses of muds from western Nebraska.

No.	Source of sample.	Soluble portion expressed as per cent of sample.	K_2O content expressed as per cent of soluble portion.
26	1 foot below surface of Jesse Lake, 40 feet from shore	9.35	25.42
77	1 foot below surface of flat, one-fourth mile north of railroad, 2 miles east of Reno post office	3.04	14.80
112	Lake at Lakeside	3.58	12.03
115	4 feet below surface of Jesse Lake	4.63	28.92
116	7 feet below surface of Jesse Lake	4.07	24.78
126	Lake in sec. 1, T. 21 N., R. 46 W	3.47	13.20
	Average of 6 samples	4.69	19.86

Potash analyses of brines from western Nebraska.

No.	Source of sample.	Dissolved salts (dried at 105° C.) expressed as per cent of original sample.	K_2O content expressed as per cent of dissolved salts.
24	Shallow pit at edge of Jesse Lake	12.31	34.81
27	Pit 4 feet deep in Jesse Lake, 40 feet from shore	14.14	26.40
62	Pond 1 mile southwest of house on Star Ranch, sec. 17, T. 26 N., R. 43 W.	3.21	35.85
73	Pond in sec. 19, T. 26 N., R. 44 W. (small)	8.15	15.50
74	Pond in sec. 19, T. 26, N., R. 44 W. (large)	4.70	31.40
79	Pond at F. C. Taylor's place, 3 miles east of Reno post office	7.20	23.14
88	Pond in northeast corner sec. 20, T. 26 N., R. 44 W	4.56	31.56
113	Middle of Jesse Lake	13.55	29.97
119	McCarty Lake, sec. 17, T. 23 N., R. 46 W	8.83	30.62
120	Pond ½ mile southeast of McCarty Lake	8.11	19.82
123	Richardson Lake, secs. 4 and 5, T. 22 N., R. 46 W	7.57	14.44
125	Lake in sec. 1, T. 21 N., R. 46 W	3.33	16.61
130	Thompson Lake, 15 miles southeast of Alliance	4.30	19.68
	Average of 13 samples	7.69	24.91

Potash analyses of saline residues from western Nebraska.

No.	Source of sample.	Soluble portion expressed as per cent of sample.	K_2O content expressed as per cent of soluble portion.
25	Crust on southeast margin of Jesse Lake	34.06	21.00
75	Alkali from road 8 miles west of north of Lakeside	4.62	6.16
78	Alkali sand south of railroad, 3½ miles east of Reno post office	8.51	11.27
94	Surface incrustation east end of Crevath Lake	34.05	17.17
113	Surface incrustation south edge of pond 1 mile west of north of Lakeside	30.85	2.40
117	Surface incrustation, Jesse Lake	20.25	17.39
122	East pond on Cluff place	8.97	29.70
124	Pond 1½ miles west of preceding	15.12	12.76
	Average of 8 samples	19.55	14.73

[1] Hance, J. H., Potash in western saline deposits: U. S. Geol. Survey Bull. 540, pp. 457–469, 1914.

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ORIGIN OF SALINES.

Hance[1] points to the marked similarity of the complete analyses of these saline lake residues to the analyses of leachings from wood ashes and suggests that wood ash is one of the sources of the alkali. The Sand Hills and adjoining meadows at one time supported a generous growth of brush and timber, and the region has reached its present condition through repeated destructive forest fires. Prairie fires have also been of frequent occurrence, and the natural leachings of these ashes may explain the concentrates in the depressions. This conclusion has also been reached by Ziegler, who thinks, further, that some alkali may also have been leached from the underlying rocks.

EXPLOITATION.

The analyses given show that the waters, muds, and crusts of Jesse Lake have the highest content of potash and this is the only lake from which potash salts are now obtained. The lake covers 240 acres and is 3 miles north of Hoffland. It is underlain by a dark greenish-colored mud, beneath which is a layer of sand, 20 feet thick in places, charged with strong brine. This sand rests on hardpan composed of dense, impervious marl, said to be rich in magnesia.

The brine that impregnates the sand shows a greater degree of concentration than the surface water, and sand pumps are therefore used to pump it. A certain quantity of surface brine is drawn in by suction, as is indicated by the lowered saline content of the brine delivered by the pump. The water as pumped is delivered to a solar tower in which the liquid flows by gravity over 20 wooden partitions ranged one below the other. The degree of evaporation obtained in the solar tower depends on temperature, wind, humidity, and possibly other factors and varies from 5 to 20 per cent.

The brine is pumped from the solar tower through 2 pipe lines to storage tanks at the main plant at Hoffland, 3 miles south of the lake. Here the company plans to erect a second tower to concentrate the brine still more before it goes to the storage tanks. The construction work on this second tower was begun in November, 1915.

From the storage tanks the brine is fed into steel evaporating vats, which are ranged in 2 sets. The first set consists of 4 vats, 12 by 16 by 4 feet, in which the preliminary concentration takes place. The second set, consisting of 2 vats, 12 by 12 by 4 feet, is for the final crystallization of the dissolved salts. The vats are heated by steel coils, suspended near the bottom. The crystallizing vats have a perforated steel plate in the bottom. The crystallization proceeds very rapidly, and as the salts settle out they mechanically retain some of the strong brine. The portion of the brine which escapes through the perforations at the bottom of the vats is caught in the sump and pumped back into the preliminary concentrators. After crystallization has proceeded to the proper point and the heat is turned off, the excess brine is pumped into storage tanks to be shipped subsequently in this raw state. The salts, which includes a considerable proportion of the residual bittern left in the crystallizing tanks, are shoveled upon a loading platform, where they drain and are loaded into tank cars. As shipped, they carry 30 to 40 per cent of brine.

[1] Op. cit., pp. 465–467.

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The company plans to equip the plant with vacuum pans and rotary driers to handle the wet salts. The delivery of this material was expected last November. As soon as the modern machinery is installed, the capacity of the plant will be increased to about 75 tons of salts a day. For the first 4 months the production averaged about 7 tons of salts a day and about 30 tank cars of brine a month. The company has made no attempt to separate the potash salts, because the demand for both the salts and the brine has been greater than the total production. The salts as shipped are mixed with tankage and used for fertilizers.

AVAILABLE SALINES.

The exact number of alkaline lakes in the western region is not known, and most of those known are not rich enough in potash to be of commercial importance. Perhaps not more than 10 per cent carry alkali enough to justify concentrating it on a commercial scale. None of the lakes with strong brines are large. Jesse Lake, which has an area of 240 acres, has been estimated to contain about 100,000 tons of saline material. As the individual lakes are generally small the erection of a special evaporating plant for one lake would hardly be considered, but a plant centrally located might be able to work profitably the brine from several small lakes. In any case operations could be carried out only on a small scale, as the total accumulation of saline material is small.

OTHER SALINE LAKES OR DEPOSITS.

Alkali Lake, Oreg.—There is a notable deposit of soda in and around a shallow and variable lake of strong brine in Alkali Valley, in southern Oregon, which occupies the bottom of one of the typical desert basins of this part of the Great Basin region. The alkali occurs as a crust on the surface of mud in and about shallow saline ponds, and there are "pot holes" about the margin of the deposit in which almost pure soda crystallizes. These "pot holes" have been worked for soda in a small way, and the deposit as a whole has been taken up by a company which designs to work it for soda and other possible products. Naturally, attention has been directed to this deposit as a possible source of potash.

This deposit was examined in August, 1915, by Hoyt S. Gale, who took samples of the brines and salts. Reports of potash tests made on these materials had not been very encouraging, but complete evidence on this point was desired. The results do not seem to offer much promise except, of course, that potash may be recovered in conjunction with other salts. For example, the brine from a pool known as Little Alkali, which is probably the largest body of open water, carries 10.63 per cent dissolved matter (ignited residue) in which potash ran 3.25 per cent as potassium, or 6.19 per cent if figured as potassium chloride. This content of potash is somewhat higher than that commonly obtained in such brines, but is not comparable, for example, with that in the brine from Searles Lake, in southern California, and the brine from Alkali Lake was less than half saturated.

Abert and Summer lakes, Oreg.—Reports are published from time to time relating to a project for extracting salt, soda, potash, and other

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mineral salts from the waters of Abert and Summer lakes, in southern Oregon. These lakes, which are of considerable size, carry alkaline salts in rather dilute solutions, ranging according to analyses available from about 3 to 8 per cent in Abert Lake and from about 2 to 4 per cent in Summer Lake. Although the aggregate quantity of salts in these waters is undoubtedly very large, the waters are only about as concentrated as ordinary sea water, and the potash, as shown by authoritative determinations, is only slightly greater than that contained in sea water. Thus, soda might be recovered from these waters by solar evaporation much as salt is now recovered from sea water, and in this connection it is also conceivable that potash might be recoverable as a by-product.

Salduro Salt Marsh, Utah.—The expected extraction of a by-product from the water of Great Salt Lake has revived interest in the possible extraction of potash from the salts or brines of the Salduro Marsh, also in Great Salt Lake Basin, west of Great Salt Lake. This deposit lies directly on the main line of the Western Pacific Railway and has been worked somewhat as a source of salt. It was examined with special reference to the possibility of obtaining potash there in October, 1914, by Hoyt S. Gale for the Geological Survey. Mr. Gale contributes the following notes:

Several shallow holes were bored through the hard surface salt crust that forms the floor of this basin and into the underlying mud. Analyses of samples taken from these borings show that the surface salt is comparatively pure sodium chloride containing an exceedingly small quantity of potassium. The water-soluble potassium contained in the underlying muds ranges from about 1.8 to 3.5 per cent (expressed as K) of the dissolved salts included in the mud, which constituted from about 12 to 15 per cent of the original samples taken, some 5 to 7 per cent of the samples being water. Brine was found both in the salt crust and in the underlying mud, and on analysis proved to be saturated solutions carrying 25.68 to 26.85 per cent dissolved salts, of which 2.8 to 4 per cent was potassium (expressed as K). This is 0.75 to 1.03 per cent of potassium in the original solution, or only about half the potassium content of the brine in Searles Lake, Cal. It is, however, about double the potash content of the water of Great Salt Lake (0.34 per cent potassium in the sample of October, 1913), which, however, is not usually a saturated solution. The brine at Salduro appears to flow freely into holes cut into the salt or mud, but it seems that the supply must be small and this might also prove an important fact in any contemplated enterprise dependent on large and regular supply of the brine. Again, though the potash prospects of Salduro are not believed to be very promising, it is possible that potash might be produced there in some form, perhaps as a by-product of some other industry, or perhaps only under the stimulus of present abnormal conditions.

Virgin River salt deposits, Nevada.—Remarkable cliffs of salt are exposed in natural outcrop along the valley of Virgin River in southern Nevada. Although these have attracted attention from the days of earliest exploration in the West, they lie in a region that is not readily accessible, and the salt has not been utilized except locally in a very small way. This region was visited in September, 1915, by Hoyt S. Gale, by whom the following notes are contributed.

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The salt ledges are exposed at several places along both sides of the Virgin River valley between St. Thomas and the mouth of the Virgin at Colorado River, the outcrops extending over a distance of at least 12 miles. Similar outcrops are also reported 30 miles east of St. Thomas, so it appears evident that the salt was originally a continuous and widely distributed stratum laid down during the formation of a certain part of the sedimentary rocks of this part of the country. The salt is associated with a great thickness of gypsum and gypsiferous shales, and is included in a series of characteristically red shales, sandstones, usually referred to as "Red Beds," of Triassic or Permian age. The beds including the salt have clearly been very much faulted and folded, so that the present outcrops represent disconnected parts of them, and it is also evident that only in exceptional positions has the salt itself been preserved in open exposures or under shallow cover above ground-water level.

It is natural to look to such a region as this for the possible occurrence of potash-rich portion of these saline deposits. The largest salt ledge exposes an almost vertical face of solid crystalline salt, representing a bed at least 100 feet in height, in nearly horizontally bedded position. The base is concealed, and the bed may be actually much thicker. The top of the salt is very sharply defined, and the bed is overlain by reddish clay and higher in the section by gypsum, shale, and red sandstone, the beds including also an interbedded flow of dark lava. Samples of the salt dug from the face of this cliff have been analyzed with the following results:

Tests of samples from Salt Cliff, 3½ miles south of St. Thomas, on Virgin River, Nev.

	Distance below top of cliff.	Soluble portion.	KCl in soluble portion.
	Feet.	*Per cent.*	*Per cent.*
1	60	94.98	0.29
2	50	98.52	0.08
5	40	97.12	0.09
6	35	98.88	0.08

The great mass of crystalline translucent salts appears to be rather uniform in composition, though it contains an interbedded layer of gypsiferous clay a few inches thick. So far as present evidence goes, therefore, it appears to carry no potash-rich layers, although it might be worth while to sample these exposed ledges even more systematically.

The other salt cliffs or exposures down the Virgin River valley, including the last one just below the "Narrows," about 6 miles above the mouth of the Virgin, were examined and some samples taken, with results similar to those already given. A salt well near Colorado River below the mouth of the Virgin was also visited and sampled, with the following results:

Tests of samples from salt well on Colorado River.

	KCl in soluble portion (per cent).
Brine containing 30.77 per cent of dissolved salts	2.39
Efflorescence about rim of well containing 33.31 per cent of water soluble matter.	1.68

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Some samples of the river waters above and below this salt field were taken on the chance that some indication concerning salt beds that were being leached might be obtained.

Tests of samples from lower Virgin River valley, Nevada.

	Total soluble salts.	KCl in total salts.
	Per cent.	*Per cent.*
Surface stream in gypsum beds on "Diehl potash claims"	0.97	3.07
Seep in Bitter Spring Draw	.38	7.82
Water from shaft on "Diehl potash claims"	4.19	.28
Virgin River water, below the salt cliffs, 5 miles above mouth	.365	Not det.
Virgin River water, below the salt cliffs near mouth	.38	4.93
Colorado River, water just above mouth of Virgin River	[a].102	Not det.

[a] This result may be too high, as sample was difficult to filter.

Probably the object of these last tests was not accomplished because the test was not complete enough. One result, that from the seep in Bitter Spring Draw, which gave 7.82 per cent of potassium chloride in the salts dissolved in a rather dilute water, may be of some significance. Of itself, of course, so dilute a water could be of no value, and the quantity of the flow is insignificant.

Potash may be present in this area, in association with the salt and gypsum, but no very definite indication of its existence, especially in commercial quantity, has been brought to light.

ALUNITE NEAR MARYSVALE, UTAH.

PRODUCTION.

The year 1915 was notable in the history of the potash-salts industry in the United States, for in that year potash salts were first obtained on a commercial scale from alunite, a hydrous sulphate of aluminum and potassium ($K_2O.3Al_2O_3.4SO_3.6H_2O$), and shipped from the plant of the Mineral Products Corporation at Marysvale, Utah. The production is, of course, small, but the enterprise that led to the establishment of the industry is worthy of recognition. This is among the first outputs of potash from a mineral source in the United States and, so far as known, it is the first production of potash salts from alunite in the world, as the foreign deposits have been worked primarily for potash alum and not for potash salts alone.

PROCESS OF PRODUCTION.

The following description of the process of preparing potassium sulphate from alunite at Marysvale, Utah, is based on information furnished to V. C. Heikes, of the United States Geological Survey.

The mill is about 5 miles southwest of Marysvale and 2 miles west of Sevier River, near the mouth of Little Cottonwood Canyon. The alunite vein, which is on the Gillan-Custer claims, is 4 miles farther west by wagon road. The mined alunite is conveyed by an aerial tramway 6,200 feet long, with a fall of 1,900 feet, to a bin at the creek level, from which it is carried by wagons over a down-grade road of 3½ miles to the mill. The tramway, under present conditions, has a rated capacity of 12½ tons of alunite an hour.

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From the ore bins at the mill the alunite passes through a gyratory crusher, next through a set of rolls, from which it is delivered to a storage bin. After being mixed with powdered slack coal, it is fed into a rotary kiln, where it is roasted. The roasted material is elevated to a storage bin, from which it is drawn off into a digester. In the digester it is mixed with water and the sulphate of potassium is dissolved out. The charges from the digester are stored in wooden tanks. From these tanks the mixture is pumped into a filter press, where the insoluble alumina and the water-soluble potash are separated. The solution is then evaporated in a triple-effect vacuum pan, and the potassium sulphate which separates out is drained, dried, pulverized, screened, and sacked for shipment.

Boilers having a rated capacity of 600 horsepower produce steam for the three engines that drive the machinery of the plant. The exhaust steam is used for evaporating the solutions and drying the product. Slack coal is used for fuel.

The capacity of the first unit of the plant is estimated to be 25 to 35 tons of potassium sulphate a day. In addition to this valuable product, the operators expect returns from the filter cake left after the potash solution has been removed from the calcined material. This cake consists of nearly pure alumina.

The mill is the first to be built in the United States to treat alunite. Its operation was begun on September 15, 1915, when some alunite was put through the crusher. Each part of the machinery was gradually tested thereafter until, by October 6, fully 200 tons of alunite had been distributed through the plant. On October 5 about 20 tons of filter cake, reported to contain 65 per cent of alumina (Al_2O_3), was discharged, and about 85,000 gallons of the saturated solution of potassium sulphate had accumulated in the evaporators, which were placed in commission on October 6. On October 7 the first potassium sulphate was produced. On October 20 the first carload of 28 tons of potassium sulphate, averaging 95.39 per cent pure, was shipped.

The recent developments, together with a review of the geology of the deposits near Marysvale and Beaver, Utah, have been summarized by G. F. Loughlin,[1] from whose report the notes on the method of operating the plant were taken. This report is still available for distribution.

OTHER OCCURRENCES OF ALUNITE.

One of the largest exposures of alunite outside of the Marysvale district, Utah, is that in the Las Vegas district, in southern Nevada. This deposit has been examined and sampled by Hoyt S. Gale for the Geological Survey, as well as by others working for private interests. The following statement has been contributed by Mr. Gale:

Although there is evidently a great quantity of alunite and alunite-bearing rock at this locality, most of it seems to be in veins so small or so widely disseminated in the country rock that it is doubtful whether it can be worked, as is the deposit at Marysvale.

The alunite deposits occur just south of a point known as Railroad Pass, 22 miles southeast of Las Vegas, about half a mile south of the rim of the broad valley that extends southeastward from this town.

[1] Recent alunite developments near Marysvale and Beaver, Utah: U. S. Geol. Survey Bull. 620, pp. 257-270, 1915 (Bull. 620K).

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The alunite occurs principally in a series of little hills which lie at the very base of the steep escarpment of volcanic rocks at the extreme upper margin of an alluvium-filled valley. These knobs or hills appear to be erosion remnants of silicified parts of a much altered porphyry. Though alunite is most conspicuous in the zone of alteration and silification represented by these knobs, the country rock thereabout is very generally altered and alunitized, as has been noted by persons prospecting for minerals at many other points.

The study of the samples collected at the Las Vegas alunite locality has not been completed, but chemical determinations made to show the potash content of samples indicate that the general run of rock as it would have to be mined at this locality would probably not average over 2½ per cent potash (as K_2O), or at the most 3½ per cent. The actual determination on one average sample of cuttings from a tunnel on the property gave 2.2 per cent K_2O, or 4.06 per cent K_2SO_4 in the water leach after ignition 1½ hours.

The alunite deposits of Nevada and the potash alum deposit near Silver Peak have been examined by Victor Barndt, of Tonopah, and his associates. Field examinations have been made and samples collected under the direction of E. E. Free at Bullfrog, Cuprite, Goldfield, and Silver Peak, near the railroad station of Blair Junction.

The several samples collected in the Bullfrog district showed only a small quantity of alunite and were therefore not analyzed in detail.

The material from Cuprite is an alunitized rhyolite tuff, with which is associated some free sulphur. A number of exposures have been located in the vicinity of Cuprite. Most of the material is poor in alunite, and laboratory tests reveal the alunite to be of the soda-bearing variety and to contain as much soda as potash. The conclusion has been reached that the material is of no importance as a possible source of potash.

The mineral alunite forms a substantial part of the gangue of some of the ores at Goldfield, Nev. It occurs associated with altered rhyolite, dacite, andesite, and latite, but, unlike the occurrence at Cuprite, no free sulphur is present. Large quantities of fairly pure alunite are available in this district in metal mining, especially on Preble Mountain, where the alunite is associated with dacite and andesite. Some might be obtained incidental to metal mining operations. Experiments, however, show that this alunite, like that at Cuprite, is of the soda-bearing variety and it is not believed that it will prove a profitable source of potash salts.

Potash alum.—The material at the Silver Peak deposit is potash alum (kalinite), with which sulphur is associated. The alum itself occurs as veins, some of them several inches thick, which split and ramify irregularly through the altered rhyolite. Analyses show that the material of the veins is practically pure potash alum, but the soluble material in the adjacent impregnated rocks includes some soda. There is little alunite present.

Some development work has been done on the deposit and it has been located and relocated many times and prospected as a sulphur mine, but the work done has not sufficed to reveal its entire extent. The material is believed to be of value as a source of potash and an

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option has been taken on the property by Victor Barndt and his associates. It is expected that development work will be done very early in 1916 to determine the exact extent of the deposit and the average grade of the potash alum.

PROCESSES OF TREATING ALUNITE.

A process has been patented by Charles H. MacDowell,[1] which relates to the treatment of alunite, alum rock, alum stone, etc., for the recovery of the contained alkaline salts, principally potash salts.

The alunite is calcined at a temperature sufficiently high to drive off the sulphur trioxide. The residual product contains alumina, insoluble in alkali, potassium sulphate, soluble in water, and a small quantity of sodium sulphate. Instead of leaching out the soluble salts the patented process involves raising the temperature of the calcined material so that they are driven off by volatilization. In practice it is found that a temperature ranging from 1100° to 1600° C. is sufficient to volatilize all the potash salts and with them the small quantity of sodium salts that may be present. When the operations are conducted at 1600° C., only traces (not more than 0.5 per cent K_2O and Na_2O) are left in the calcined alunite treated. The volatilized alkaline salts may be recovered as such in solid form by conveying them into a cooling flue where they deposit.

The process avoids leaching and may be important in localities where water is scarce.

The patent also relates to the discovery that if calcined alunite in a finely divided condition is mixed with 20 to 50 per cent carbon in the form of powdered coal, coke, or lampblack the temperature of volatilization may be considerably lowered and may begin as low as 800° C.

A process of obtaining potassium sulphate from alunite, patented by George S. Morgan,[2] consists of grinding alunite, mixing it with lime in the proportion of four parts of alunite to one of lime, and furnacing the mixture in a rotary furnace. The heat is directed into the discharge end of the furnace and the temperature is raised to 1,200° to 1,800° F. and maintained until the reaction is complete.

The roasted mixture is placed in leaching vats while still hot. Water is added and the mixture is agitated by live steam. The partly saturated solution is directed to the next vat and again agitated and this process is repeated until the solution is concentrated at a temperature of 200° F. The solution next goes to crystallizing vats, where it cools and the salts separate. The mother liquor is then used to dissolve potash salts in that leaching vat containing the roasted alunite which has been leached the most; it passes then through different vats in succession to the vat containing the roasted material which has just come from the furnace. In this way it becomes thoroughly saturated. The potassium sulphate crystals are then removed, dried, and ground, or otherwise treated.

A point that is emphasized in connection with this process is that the sulphur dioxide produced combines with the lime and none passes into the air.

[1] U. S. patent 1136549, dated April 20, 1915.
[2] U. S. patent 1161239, dated November 23, 1915.

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POTASH SALTS FROM SILICATES AND OTHER SOURCES.

GENERAL CONDITIONS.

The subject of the extraction of soluble potash salts from the silicates, such as feldspar, leucite, and sericite, and from greensand has been discussed ever since the question of a domestic supply of potash was broached. Many patents for such processes have been issued, but the problem of doing the work at a profit is still to be solved. One difficulty is the location of large deposits of uniformly high-grade material. Large deposits of feldspar of uniformly high grades are not plentiful. Of leucite and greensand there is abundance; and the supplies of greensand especially are very accessible. Whether the greensand will prove to be of sufficiently high grade or whether it can be brought up to workable grade is not known.

All processes for extracting potash salts from the silicates include both the mining and transportation of raw material and also the accessory materials needed for the reactions. Further, in the practical manipulation of all the processes devised, there is generally involved fusion, sublimation, extraction, filtration, concentration, crystallization, drying, grinding, sorting, and bagging, a series of operations which will make potash so expensive that under normal trade conditions it can never hope to compete successfully with German potash salts at the prices at which they can be sold in this country.

W. H. Bowker[1] has said that

> The (German) potash industry has been one of the most profitable in the world. It is said that muriate of potash, the standard grade (50 per cent K_2O), can be mined and delivered at the seaboard of this country for $15 a ton and show a handsome profit. I am told that it was stated in debate in the Reichstag in 1910 that the best mines in Germany could mine the mineral and refine it for about $8 a ton. The price in cargo lots is from $33 to $34 per ton delivered at seaboard. Through the German Kali Syndicate the production of the mines is limited by allotment and the price is arbitrarily fixed. It is stated that there have been more than a hundred well-equipped mines, with a capacity equal to six times the world's consumption.

Only those who have experimented with the processes of deriving potash salts from the silicate rocks and minerals on a large scale are in a position to speak with authority on costs, and not much has been published on this phase of the work. A. S. Cushman and G. W. Coggeshall[2] have discussed costs and estimate at $28.80 per ton the cost of potassium chloride of 80 per cent grade (50 per cent K_2O). This corresponds to a cost of 2.88 cents per pound of K_2O. If German potassium chloride of the 80 per cent grade can be delivered at our seaboard for $15 per ton and show a handsome profit, the hope for the successful establishment of a domestic potash-salts industry near the Atlantic seaboard, except during abnormal times like the present, seems rather remote. The farther inland and the higher the freight rates the better the opportunity for a domestic industry to compete; but the fact must be borne in mind that the largest domestic consumption of potash salts is in the Eastern and Southeastern States, where freight rates from seaboard cities to inland points are not high.

In the preparation of soluble potash salts from the silicate rocks, especially for the fertilizer trade, which consumes more than 90 per

[1] Jour. Ind. and Eng. Chemistry, vol. 7, No. 1, pp. 59–61, Jan., 1915.

[2] From a paper presented before the Seventh Ann. Mtg. Am. Inst. Chem. Eng., Philadelphia, Pa., Dec. 2, 1914, reprinted in the American Fertilizer, Dec. 12, 1914.

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cent of the imported material, the problem is not necessarily one of extraction of the pure salts, though the demand for these is acute in certain branches of the chemical industry. If the potash is rendered soluble in the mass, this mass can be used in mixed fertilizers. A product, however, of too low grade will not be in demand when conditions are normal, for the trade in German potash has resulted in a demand for the higher grades.

A fact worthy of serious consideration is that most of the processes devised will yield by-products of value; indeed, the obtaining of a by-product of value may be the determining factor between profit and loss in practically all of them.

LEUCITE ROCKS, WYOMING.

A. H. Rogers,[1] of Boston, has outlined some experiments with the potash-bearing rocks of the Leucite Hills, Wyoming, made with the object of abstracting soluble potash salts from them on a commercial scale. Both the wet and the dry methods of treatment were tried. Leucite, in contrast with feldspar, is very easily decomposed, and, unlike most silicates when decomposed by wet acids, it yields its silica in the granular and not in the gelatinous condition, a fact which makes the wet treatment possible. It was found that when leucite rock was treated with sulphuric acid to which a little hydrochloric acid had been added complete solution of the bases resulted. It was thought that this process might solve the problem, but the resulting sulphates were about as hard to separate as were the constituents in the rock itself. The digestion of the leucite rock with caustic lime under high pressure was also tried, and the procedure was varied by using caustic soda and even sodium chloride, with the idea that the sodium might replace the potassium more effectively than lime. The results from these tests were not encouraging.

The rock was next treated with sulphur dioxide gas at a temperature of 1,200° C., and the Hargraves process, which is used for making sodium sulphate from common salt by passing steam and sulphur dioxide over it at a temperature of about 500° C., was also employed. The results from these tests were likewise not encouraging and for the time being experiments by the wet method have been discontinued.

Almost all the present known dry processes that appear to offer any possible hope of success have been tried, and it has been found that when a mixture of leucite rock, lime, and gypsum is heated to the proper temperature, the potash can be quantitatively extracted in the form of the sulphate. With some of the experiences of the cement manufacturers in mind, in which quantities of alkalies contained in limestone are volatilized, many experiments were made, but they were not completely successful, as at times much of the potash would be driven off, at other times very little. Heating the leucite rock with phosphate rock produced no results. The Cowles process, devised to extract alumina from clay, was also tried. In this process, a mixture of salt and clay is compressed into briquets and heated, whereby hydrochloric acid is given off and alkali-silico-aluminate formed; this compound is then decomposed by heating with limestone to form a lime silicate, a soluble alkali aluminate being left. Briquets were made and heated in the Cowles furnace, but very unsatisfactory results were obtained.

[1] Min. and Metall. Soc. America Bull. 83, vol. 8, No. 4, pp. 93–95, Apr. 30, 1915.

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The conclusion has been reached by practically all the investigators that the commercial treatment of the silicates is hopeless unless alumina can be recovered also, a conclusion shown in recent patents, which all aim to produce something in addition to potash salts. In common with many other experimenters, F. A. Rody found that when silicates are heated with limestone the potash is freed, but he also found that if the lime is in the proper proportion all the bases are set free, with the exception of magnesia. The alkali combined with alumina, being soluble, may be leached out. Rogers[1] says:

> The ability to recover alumina in such a simple way is, we believe, the solution of the problem. The process consists of grinding the mixture of leucite and limestone in proper proportions, just as in cement manufacture, and furnacing it in a cement kiln. The clinker produced is somewhat similar to cement clinker and it is simply ground and leached. Nothing but alkali and alumina go into solution and these can be separated just as in bauxite refining. The resulting alumina is just as good as that produced from bauxite. We have been doing this for about a year now in a small experimental kiln; and while, due to difficulty of temperature control, we do not always get high extraction, we consider it possible that with the uniform conditions possible of maintenance in a large furnace, we can recover 75 to 80 per cent of these two substances.[2]

SERICITE.

Sericite, a variety of muscovite or potash mica, is a fine scaly or fibrous mineral. Chemically it is an orthosilicate of potash and alumina, containing in the theoretically pure mineral 11.8 per cent of potash (K_2O). It has been considered as a source of potash salts and some of it has been experimented with.

Some of the best known sericite deposits and those spoken of as sources of potash are at or near Jasper, Pickens County, Ga. They occur in beds or lenses of practically pure sericite; some beds at least 5 feet thick have been measured and thicker ones have been reported. They are in places continuous over considerable areas.

The sericite is very uniform in character, both physically and chemically, both below, above, and at the water level. Only at the surface, where it is disintegrated by weathering, does it vary in appearance and composition.

The following analysis of sericite was sent to the Survey by Prof. S. W. McCallie, State geologist, Atlanta, Ga.:

Analysis of sericite from the William Richards property, Pickens County, Ga.

[Edgar Everhart, analyst.]

Moisture at 100°	0.12
Loss on ignition	3.96
Soda (N_2O)	.20
Potash (K_2O)	10.75
Lime (CaO)	.00
Magnesia (MgO)	.40
Alumina (Al_2O_3)	34.29
Ferric oxide (Fe_2O_3)	2.96
Ferrous oxide (FeO)	.72
Manganous oxide (MnO)	Trace.
Titanium dioxide (TiO_2)	.56
Silica (SiO_2)	46.17
	100.13

[1] Op. cit.

[2] See also Rody, F. A., U. S. patent 1151533, dated August 24, 1915.

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GREENSAND.

The greensands of New Jersey, Delaware, and Maryland are found in Cretaceous rocks. They contain glauconite, a hydrous silicate of potash and iron, which forms a large part of several Cretaceous formations in these States. The greensand-bearing formations extend southwestward across New Jersey in Monmouth, Burlington, Camden, Gloucester, and Salem counties, and continue southwestward into Delaware and Maryland.

The glauconite in New Jersey is found in the Marshalltown, Navesink, Hornerstown, and Manasquan formations. These subdivisions of the Cretaceous system may be readily followed on the geologic map [1] issued by the Geological Survey of New Jersey, and are described in detail in the report [2] that accompanies that map.

Though the four greensand-bearing formations do not consist entirely of greensand they nevertheless contain greensand beds so thick and so widespread in areal extent that they are of special interest as sources of fertilizer. In former years large quantities of greensand were dug from them for use in agriculture and they still furnish a small quantity, a little of which is used in some prepared fertilizers. In recent years, however, greensand has been supplanted by more concentrated commercial fertilizers.

The greensand contains both potash and calcium phosphate, and some of the so-called shell marls contain also calcium carbonate, all three of which are of value as fertilizer. Samples of these greensands collected in January, 1916, were analyzed by W. B. Hicks to determine their content of potash. The results of these analyses are given below.

Potash in greensands of New Jersey and Delaware.

Samples collected by W. C. Phalen.

No.	Percentage of potash (K_2O).	No.	Percentage of potash (K_2O).
1	3.54	8	5.14
2	4.90	9	6.26
3	4.86	10	5.92
4	4.28	11	6.22
5	3.74	12	5.76
6	4.22	13	3.36
7	4.22		

1. Northeast of Farmingdale, Monmouth County, N. J.
2. East of Marlboro, Monmouth County, N. J.
3. Near Marlboro, Monmouth County, N. J.
4. Between Pemberton and Vincentown, Burlington County, N. J.
5. Near Vincentown, Burlington County, N. J. From a heap already dug.
6. Near Vincentown, Burlington County, N. J.
7. One and one-half miles northeast of Pemberton, Burlington County, N. J. From a recent stock pile.
8. One and one-half miles northeast of Pemberton, Burlington County, N. J.
9. North of Birmingham, Burlington County, N. J.
10. Two miles southwest of Mullica Hill, Gloucester County, N. J.
11. West of Sewell, on Chestnut Branch, Gloucester County, N. J.
12. Southwest of Laurel Springs, Camden County, N. J.
13. From an old heap on the Chesapeake & Delaware Canal near Delaware City, Del.

It is of interest to compare these analyses of greensands with those published in an early report [3] of the State geologist of New Jersey.

[1] Lewis, J. V., and Kümmel, H. B., Geologic map of New Jersey: New Jersey Geol. Survey, 1910–1912.
[2] Lewis, J. V., and Kümmel, H. B., The geology of New Jersey: New Jersey Geol. Survey Bull. 14, pp. 63–69, 1915.
[3] Clarke, W. B., New Jersey Geol. Survey Ann. Rept. for 1892, pp. 230–231, 1893.

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Potash in greensand (marls) in Monmouth and Middlesex counties, N. J.

No.	Percentage of potash (K_2O.)	No.	Percentage of potash (K_2O.)
1	1.54	8	4.47
2	3.79	9	3.10
3	5.27	10	7.08
4	3.65	11	5.29
5	3.82	12	3.97
6	6.46	13	4.98
7	3.78		

1. Clay marl from point near Mattawan.
2. Clay marl from Matchaponix Creek, 3 miles south of Spottswood.
3. Lower marl from Navesink Highlands.
4. Lower marl from north shore of Navesink River, at Red Bank.
5. Lower marl from Hop Brook, near Marlboro.
6. Lower marl from northwest slope of Mount Pleasant hills.
7. Lower marl from point north of Freehold.
8. Lower marl from indurated layer at Tinton Falls.
9.
10. Middle marl from point near Eatontown.
11. Middle marl from point southeast of Freehold.
12. Upper marl (Manasquan) from Poplar.
13. Upper marl (Shark River) from Shark River.

Besides glauconite the greensand contains variable quantities of finely divided iron oxide, clay, and silt, which are lighter than the glauconite itself; also large particles of quartz and other minerals that contain no potassium. These larger particles may be removed by passing the material through a 40-mesh or preferably a 20-mesh sieve, so that the particles that are lighter than the glauconite may be washed or floated away. By this and other mechanical processes the glauconite in these greensands, and hence the content of potash, may be increased.

Nearly all the samples of greensand collected by the Survey were taken from deposits that lie near lines of transportation. The greensand deposits of New Jersey and the neighboring States are close to railroads and to navigable water and can be easily and cheaply worked, for their overburden is in few places great. Even without treatment they are a valuable fertilizer. In the voluminous discussion of sources of potash salts in the United States the greensands of New Jersey and near-by States seem to have been overlooked, but their composition and occurrence should commend them to the attention of those who are experimenting with the silicates as a source of soluble potassium salts.

H. P. Bassett,[1] of Catonsville, Md., has described a process of obtaining potassium salts from greensand that consists chiefly of glauconite. Bassett has found that the potassium content of greensand can be made soluble in water by heating the material to a reacting temperature with sodium acid sulphate and sodium chloride, the reaction being carried out preferably in the presence of reducing agents, such as coke, which should be present in such quantity as to reduce only part of the sulphate. The proportions in which the substances are to be used are given.

[1] U. S. patent 1159464, dated Nov. 9, 1915.

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COPPER AND GOLD ORE TAILINGS.

Attention has been called by the United States Geological Survey [1] to the fact that potash occurs in the tailings that are produced in immense quantity at copper and gold concentration plants in certain western mining districts. Some masses of these tailings contain a percentage of potash high enough to make them of commercial interest, provided a process can be devised for its profitable extraction. The tailings are already in a finely divided form and are generally well located with respect to cheap transportation and to cheap supplies of electric and water power.

The tailings themselves would probably never bear the cost of transportation for their content of potash, for most of the masses contain no more potash than the abundant and accessible deposits of greensand in New Jersey and possibly other Eastern States; but as raw material already available and in convenient form for local potash salts industries they deserve the careful attention of chemical and mining engineers.

RECENT PROCESSES FOR EXTRACTING POTASH SALTS FROM SILICATE ROCKS.

M. F. Coolbaugh and E. H. Quinney,[2] of Rapid City, S. Dak., describe a process for producing potassium and aluminum sulphates.

Feldspar, leucite, or other rock is first crushed to pass through an 80-mesh sieve and then mixed with similarly pulverized gypsum or limestone in proportions that have been carefully determined. The mixture is heated to incipient fusion, cooled quickly, and crushed. It is then leached with water containing sulphuric acid, the quantity of which is regulated by the amount of potash and alumina present. After leaching, the potassium sulphate and the aluminum sulphate are separated from the solution by crystallization. The yield is 90 to 92 per cent of potash and 93 to 98 per cent of the alumina contained in the rock treated.

Samuel Peacock [3] describes a process of decomposing alkali-metal-silicates as follows:

A potash-bearing silicate, like feldspar, is mixed with ground coke, coal dust, or finely divided carbon, and is heated to about 1,500° to 1,600° C. in an atmosphere containing nitrogen, but substantially no oxygen, and the potassium, sodium, and aluminum are largely separated as volatile carbo-nitrides (K_2CN_2, Na_2CN_2, and $Al_2C_3N_6$). A pressure below that of the atmosphere facilitates decomposition and increases the proportion of the volatile to the solid products.

The carbo-nitrides obtained may be condensed and treated with hot water, or they may be led directly into water. Decomposition takes place with evolution of ammonia, which can be recovered. The carbonates of sodium and potash and pure alumina are produced as indicated by the following reactions:

$$Na_2CN_2 + 3H_2O = Na_2CO_3 + 2NH_3$$
$$K_2CN_2 + 3H_2O = K_2CO_3 + 2NH_3$$
$$Al_2C_3N_6 + 9H_2O = Al_2O_3 + 3CO_2 + 6NH_3$$

[1] Butler, B. S., Potash in certain copper and gold ores: U. S. Geol. Survey Bull. 620, pp. 227-235, 1915.
[2] U. S. patent 1125007, dated Jan. 12, 1915.
[3] U. S. patent 1134413, dated Apr. 6, 1915.

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This process may also be described as a process for the fixation of atmospheric nitrogen, the principle of which is explained in another patent by Samuel Peacock, namely, United States patent No. 1154800, dated September 28, 1915.

E. E. Dougherty [1] has devised a process for obtaining potash from leucite rocks. When leucite is treated with hydrochloric acid the potash and alumina it contains are extracted. The sandy siliceous residue that is left contains a small amount of potash and alumina, which can be easily recovered by washing. Hydrochloric acid, however, is expensive, and the potash and alumina can be extracted with sulphuric acid mixed with from 2 to 5 per cent of hydrochloric acid.

The leucite is finely ground and sulphuric acid is added in quantities sufficient to combine with the bases. Hydrochloric acid is then added in the proportion of 2 per cent by weight of the leucite. The mixture is then heated and stirred till it becomes pasty. The heat is increased until the remaining water goes off, next the hydrochloric acid, and then the excess of sulphuric acid. These acids may be recovered.

The baked mass is lixiviated with boiling water, whereupon the potash and alumina go into solution as sulphates and may be recovered by any suitable means. Common salt may be substituted for hydrochloric acid, and the quantity of sulphuric acid also should then be increased sufficiently to react with the salt.

S. E. Melkman [2] has patented a process for producing soluble potash salts from silicate rocks. It consists of mixing finely divided feldspar with common salt and carbon, also in finely divided form, and subjecting the mixture to the action of concentrated sulphuric acid at a temperature of about 200° C. The resulting product is then roasted in a suitable furnace in the presence of air, preferably at a temperature so low that the reaction will take place without fusion. The temperature, however, should be high enough to volatilize a small quantity of potash, as this insures maximum decomposition of the feldspar. Good results have been obtained at temperatures ranging from 1,000° to 1,150° C.

The resulting clinker may be ground and the potash salts dissolved in water. When the temperature has been high enough to volatilize potash salts, they may be recovered by any of the usual methods. The recovery of the hydrochloric acid produced during the first stage of the reaction lessens the cost of production.

C. W. Drury [3] has patented a process for treating silicate-bearing minerals like feldspar and leucite. The aim is not to obtain the potassium as chloride or sulphate, but to obtain a product which, though still a silicate or a mixture of silicates, is readily decomposed by dilute acids or even by acids of the soil.

The feldspar is heated with lime or limestone and iron oxide in a blast furnace. Carbon in the form of coke is added, which, while serving as the fuel, reduces the iron to the ferrous form, in which it enters the slag. The materials may be mixed together in lumps and the coke added before they are put into the furnace.

The resulting product is a siliceous slag which, when ground, may be used in fertilizers or may be further treated to obtain its potash. The product appears to be a mixture or solid solution of the silicates of iron, calcium, aluminum, and potassium, but, unlike the original

[1] U. S. patent 1148156, dated July 27, 1915.
[2] U. S. patent 1148850, dated Aug. 3, 1915.
[3] U. S. patent 1150815, dated Aug. 17, 1915.

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double silicate (feldspar), it is readily decomposed by a one-half per cent acid solution.

F. A. Rody,[1] as already noted (p. 116), has patented a process which is based on the discovery that, if oxides of the alkaline earth metals are mixed with silicates like feldspar and leucite in such proportion that for each molecule of silica the mixture will contain two molecules of the alkaline earth metal oxide, and if the mixture be next sintered, the reaction will yield a silicate of the alkaline earth metal and the alkali and alumina will be released in a condition in which they are readily soluble in water. From the aqueous solution they can both be recovered in substantially pure form.

Limestone and dolomite, either calcined or uncalcined, may be used as a source of the alkaline earth oxide. When these are not obtainable, calcium or magnesium chloride may be substituted. Calcium chloride has a certain advantage, for it may be recovered in solution at a later step in the process and its use produces a more intimate intermixture of the alkalies with the silicates.

A process described by F. A. Rody and H. M. Burkey[2] is an improvement or modification of that outlined in patent No. 1151533. It involves the reduction of at least half the quantity of reagent required to combine with the silicate. This result is accomplished by substituting an alkali, such as sodium carbonate, for part of the lime in the mixture. The two reagents are added in such quantity that there shall be two molecules of alkali for one molecule of alumina and one molecule of calcium oxide for each molecule of silica.

The mixture is sintered, crushed, boiled with water, and the alkali and alumina are separated as alkali aluminate by filtration or otherwise. This aluminate may then be recovered from the solution and a part of it used, either with or without additional sodium carbonate, for mixing with other crushed feldspar and leucite.

A proposal is made by A. C. Spencer and K. P. McElroy[3] to produce potassium cyanide or sodium cyanide by treating rocks of high alkali content in a blast furnace.

Raw materials indicated as suitable for this process are greensand, feldspar, leucite, basalt, nephelite, and syenite.

Perhaps the most interesting feature of this proposal is that it contemplates the fixation of atmospheric nitrogen on a large scale without the use of electrical energy.

A. C. Spencer[4] proposes to recover potassium compounds from feldspar, leucite, basalt, or other potash-bearing rocks by volatilization. A by-product of building bricks made from the hot plastic clinker is contemplated.

In this specification reference is made to a patent application describing the simultaneous production of Portland cement and potash fume from feldspar and feldspathic rocks.

A. W. Heyman[5] has outlined improvements in processes for the simultaneous production of soluble alkaline hydroxides, namely, those of potassium and sodium, and cement making materials, from such siliceous or argillaceous products as feldspar, granite, slate, mica, shale, clay, cement rock or argillaceous limestone used in making cement, and similar substances.

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[1] U. S. patent 1151533, dated Aug. 24, 1915.
[2] U. S. patent 1151498, dated Aug. 24, 1915.
[3] U. S. patent 1156106, dated Oct. 12, 1915.
[4] U. S. patent 1157437, dated Oct. 19, 1915.
[5] U. S. patents 1160171 and 1160172, dated Nov. 16, 1915.

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The material is ground to a fine powder and intimately mixed with finely ground limestone, gypsum, marl, or other calcareous material. The quantity of calcareous material added depends largely on the chemical composition of the material treated; if the mixture already contains sufficient calcareous material no more is added, and the preliminary grinding and mixing may be omitted.

The mixture, either natural or artificial, is next heated in a suitable kiln or furnace to a red heat or higher, preferably to a temperature between 900 and 1,600° C. The hot material may be plunged into water or it may be allowed to cool and then, either ground or unground, placed in water. By this treatment the hydroxides of potassium and sodium are extracted. The solution is then evaporated with or without the conversion of the hydroxide into the carbonate, sulphate, chloride, nitrate, or any other desired salt.

The residue remaining from the extraction may be dried and ground as an alkali-free Portland cement, provided its content of calcium oxide bears proper relation to that of the argillaceous material. If this relation is not correct it must be made so by the addition of the proper quantity of the material that is lacking.

BY-PRODUCT POTASH IN THE CEMENT INDUSTRY.

Potash was first produced from cement dust by the Cottrell process (invented by F. G. Cottrell, chief metallurgist of the Bureau of Mines) by the Western Precipitation Co. at the plant of the Riverside Portland Cement Co., near Riverside, Cal. The experimental plant was not installed to obtain potash salts but to mitigate the dust nuisance, which had caused the company both expense and annoyance. In that plant, however, the precipitation of the dust by electricity in the manufacture of cement has proved to be a practical and commercial method of obtaining potash.

The raw mixture used by the Riverside company contains a feldspar having a small content of potash. In burning this mixture the potash is volatilized, caught, and concentrated in the precipitation of the dust. When the Riverside plant is working at full capacity one special kiln is used for reburning the accumulated dust, which is first mixed with sufficient raw material to balance the feed. In this special kiln the potash is further concentrated.

Analyses made by the Western Precipitation Co. show that the proportion of potash in many raw mixtures used at different cement plants throughout the country is larger than in the mixture at Riverside. The manufacture of by-product potash not only yields a considerable revenue, but the flue dust is saved and converted into cement and the dust nuisance is thereby eliminated.

The potash recovery plant at Riverside, Cal., which has been in operation since January, 1913, was noticed in Mineral Resources for 1912. Since the precipitation process was installed at Riverside about a million cubic feet of gas a minute has been treated, thus preventing the discharge of a hundred tons of dust a day over the surrounding orange groves,[1] besides producing a revenue from the potash recovered.

[1] The Cottrell process and its applications are discussed in Smithsonian Inst. Ann. Rept., 1913, pp. 653-685. See also abstract of a recent paper by F. G. Cottrell, entitled "Recent progress in electrical smoke precipitation," presented before Section VII, subsection 2, Second Pan American Scientific Congress, Washington, D. C., Jan. 4, 1916.

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It is understood that appliances for recovering by-product potash in connection with the manufacture of cement are being installed at the plants of the Security Cement & Lime Co., at Security, near Hagerstown, Md., and the Universal Portland Cement Co., Duluth, Minn., and also at a special plant in Buffalo, N. Y.

The problem of obtaining potash salts from the dust and gases formed at cement kilns and possibly also from those formed at iron blast furnaces is now interesting because of the high price of potash salts. When these two fields have been thoroughly investigated the experiments may be extended to copper and lead smelting, but those industries may wait until the others have been thoroughly covered. The possibility of obtaining potash salts as a by-product in connection with leaching processes in metallurgy is also interesting and this may prove to be a field for fruitful research.

S. B. Newberry,[1] of Baybridge, Ohio, has outlined a process for recovering alkali from cement kilns. According to the patent, the quantity of alkalies contained in cement clinker under given conditions of burning is practically constant and is not increased by increasing the proportion of alkalies in the raw mixture. The quantity of alkalies remaining in the clinker may be reduced to a minute percentage by increasing the temperature and the time of exposure to high heat beyond the temperature and time ordinarily employed.

Only a very small part of the alkalies volatilized in the kiln is deposited with the flue dust and this is chiefly in a form insoluble in water. The remaining alkali may be almost completely recovered from the stack gases by bringing them into intimate contact with sprays of water or by passing the gases through a space fitted with porous material, the surfaces of which are kept wet with water. In this way there is obtained a solution containing the smaller part of the alkali in soluble form and an insoluble sediment or mud containing the larger part of the alkali in insoluble form. If the insoluble matter is separated from the solution by filtering or subsidence and is returned to the kiln with the fresh raw material, the percentage of alkali in that material is thereby increased. As the alkali in the clinker remains practically constant it follows that an increased amount of alkali is volatilized and that a stronger solution and a mud richer in alkali are obtained.

The proportion of soluble to insoluble alkali recovered remains practically the same, and consequently by continually returning to the kiln the flue dust and mud containing insoluble alkali a progressively increasing quantity of soluble alkali is recovered, until an amount of soluble alkali practically equal to the total alkali content in the raw mixture is regularly obtained.

Newberry illustrates his process with figures and also describes important results of his experiments and devices, which he has found of great advantage in recovering the maximum quantity of alkalies from the raw materials used in making cement.

An invention of Samuel Peacock[2] relates to a process of obtaining potash salts from flue dust. According to Peacock, in the ordinary processes of furnacing raw mixtures in the manufacture of Portland cement, 50 to 75 per cent of the potassium contained in the furnace charge is volatilized and passes out of the kiln with the flue dust.

[1] U. S. patent 1150295, dated Aug. 17, 1915.

[2] U. S. patent 1124798, dated Jan. 12, 1915.

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Furthermore, of the total potassium found in the dust 40 to 60 per cent is usually combined as a basic silicate, which is insoluble in water.

In the process patented the flue dust is treated with water to extract any soluble potash salts. To recover the potash from its insoluble silicate combinations a solution containing monocalcium phosphate is employed, for it has been found that when potassium silicate is finely ground and treated or digested with a hot solution containing monocalcium phosphate a reaction occurs yielding potassium phosphate and calcium silicate. Peacock has also found that when calcium silicate, which contains a potassium salt, is finely ground and digested with sulphuric acid the potassium is recovered in the form of the soluble salt of the acid used.

The proposal is made by A. C. Spencer [1] to recover potash products from natural cement rock.

The magnesian cement rocks referred to are those formerly used for making natural cement in various Eastern States and in Ohio, Illinois, and Wisconsin. No general study of the potassium content of these cement rocks has been made, but data at hand indicate that they may carry from 1.5 to perhaps 3 per cent potash (K_2O).

KELP.

PLANTS IN OPERATION.

A few firms appear to have seriously undertaken the production of potash salts from kelp, and the outlook seems favorable for the establishment of such an industry. At least three companies are at work on plants in which kelp will be treated. Two of them, the American Products Co., Long Beach, Cal., and the Hercules Powder Co., of Wilmington, Del., with works at Chula Vista, Cal., are utilizing kelp for other products than potash salts and their intention is to market the potash as a by-product. One of these firms will handle about 500 tons of wet kelp a day and the other approximately 1,000 tons. Harvesters have been constructed for cutting the kelp, which have been tried out and found to work satisfactorily. Another company, the Swift Fertilizer Co., with headquarters at San Diego, Cal., will treat kelp primarily for the extraction of potash salts. The Pacific Potash Co., of Seattle, Wash., reported to the Survey late in 1915 that it expected to have "a product of dried kelp" ready for market early in 1916. In addition to these firms, several small companies have been formed to produce potash salts from kelp along the Washington and southern California coast. Their operations are not now of importance.

PROCESSES FOR TREATING KELP.

Carl Klingbiel [2] has patented a process for making potassium and sodium salts from kelp ashes. Previous methods are claimed to have many defects, which are pointed out. It was found that the addition of phosphoric acid in excess to the saturated liquors of the ashes greatly simplified and improved the separation of potassium and sodium salts, as well as the extraction of iodine. Excess of the acid decomposes the carbonates, sulphides, sulphites, and thiosulphates. Excess acid is

[1] U. S. patent 1146532, dated July 13, 1915. [2] U. S. patent 1162617, dated Nov. 30, 1915.

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neutralized by adding a suitable alkali. The sulphuric acid present is removed in the form of sodium sulphate.

When the neutral liquor is boiled down, the potassium salts crystallize out on cooling and the sodium salts are removed from the hot solution. The final liquor, very rich in iodine and of small volume, may be treated with chlorine for the removal of the iodine. The mother liquor, colored brown with the latter, still carries some potash. To save this and the iodine, the mother liquor and the wash water are used to dissolve fresh lots of kelp ashes, by which method the iodine is at once fixed by the sulphides and sulphates in them.

This process is claimed to allow no loss of potassium. The sodium salts are obtained quantitatively and free from alkali-metal-carbonate and may be used for any suitable purpose. The separation of sodium and potassium salts is easily accomplished, as compared with other methods. The phosphoric acid is combined with potassium and the resulting potassium phosphate has a considerable value as fertilizer.

S. R. Oppenheim [1] has patented a process for producing charred kelp. In the furnaces described a down draft is used and one or more injector burners adapted to project the flame directly upon the surface of the kelp are provided. Drawings are given to illustrate the pattern of the furnace preferred and the method of manipulation is also explained.

According to the patent, a 1,000-pound charge of kelp may be reduced to a charred condition in from 45 minutes to 1 hour, in contrast with older methods, according to which as much as 48 hours may be required. Three gallons of oil are needed for fuel, compared with 30 gallons for the same charge by older methods.

One of the objects sought is to reduce the charge in such a manner as to prevent waste of the potash or other salts. To accomplish this an average temperature of about 350° C. is kept within the furnace; therefore no decomposition or volatilization takes place and the change to carbonates is avoided. Still another object is so to treat the kelp as to leave the residue after leaching in such a condition that it may be used for a variety of purposes. This residue consists of pure vegetable carbon, which may be used for (1) filtering and deodorizing; (2) medicinal purposes; (3) carbon for arc lamps; (4) paints and inks; and (5) on soils. The old methods left a residue consisting chiefly of ashes and clinker; the residue from Oppenheim's process is said to be valued at $10 a ton.

MISCELLANEOUS SOURCES OF POTASH SALTS.[2]

Miscellaneous sources of potash salts have been much discussed during 1915, most of them being organic sources like molasses residues, the residues from grape fermentation (argols), excreta from animals, wool scourings (suint), municipal wastes, the ashes from sea grasses, and especially the ashes from mesquite, and sage brush, so common in parts of our Western States.

The latter source of soluble potash salts attracted considerable attention during the early part of 1916. A sample of the ashes from Parowan, Utah, was examined by the Survey and found to represent 2.97 per cent of the original wood. It contained 21.06 potash (K_2O).

[1] U. S. patent 1141482, dated June 1, 1915.

[2] Some of these miscellaneous sources of potash salts were described at length in the reports on potash for 1910 and 1911.

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Other samples of ash have been reported to run more than 30 per cent in potash, and from this high figure the content ranges to a very low one. Care in burning the wood has to be exercised, for unless this is done more or less of the potash may form insoluble compounds with silica. The lower the quantity of soluble potash the less the demand there is for the ash and the less the probability of its being able to stand the high freight rates to points in the Eastern States, where the greatest demand exists.

S. W. Sinsheimer[1] has invented a process for the recovery of the concentrated product containing nitrogen and potash from the waste liquors resulting from the separation of sugar from molasses obtained from sugar beets.

In the commercial process for making sugar from sugar beets there results a waste liquor containing considerable quantities of lime, potash salts, and nitrogen. Owing to the presence of much water and scale-forming substances, this liquor has heretofore not been used, and it is the object of this invention to save it and make use of it as fertilizer.

The liquor is first heated and such solids as are precipitated are filtered off and the solution is then treated with carbon dioxide gas. The insoluble carbonates which form are removed by filtration and the solution then goes to a multiple-effect evaporator. The mass delivered from the last effect is dried at a low temperature to prevent loss of nitrogen compounds. The dried product contains 3 to 5 per cent nitrogen and 12 to 25 per cent potash, reckoned as oxide. If the filtrate from the insoluble carbonates is treated with sulphuric acid, the potash remaining in the dried mass is in the form of the sulphate.

FOREIGN DEPOSITS OF POTASH SALTS.

SPAIN.[2]

During recent years interest has been directed to the potash deposits in the provinces of Barcelona and Lerida, in the northeastern part of Spain. Borings and analyses have been made with favorable results. In various borings near the town of Sarria, potash salts were found at depths between 121 and 197 feet, and also at a depth of 426 feet. At a depth of 886 feet, the greatest attained, potassium salts were found resting on a bed of white salt which was not pierced. In the area tested by borings, which comprised between 61 and 62 acres, there is an estimated quantity of 2,550,000 tons of carnallite and 1,150,000 tons of sylvite.

From the general character of the region it is considered probable that other deposits of potash salts will be found close to those already discovered. A considerable percentage of potash salts has been found in the waters of the stream running by the salt works at Cardona, and it has been further discovered that large quantities of potash salts have been allowed to go to waste in these mines which might have been used.

The complex character of the geology in the region near Barcelona renders it difficult to make close quantitative estimates of the potash

[1] U. S. patent 1134921, dated April 6, 1915.
[2] Hurst, C. B., U. S. Consul General, Barcelona, Spain, supplement to Commerce Reports No. 15c, July 10, 1915.

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salts available. The presence of gypsum beds and the potash-bearing stream waters, however, should serve as guides in locating new deposits or continuations of those already known.

Interest has been displayed in these salts by certain firms in the United States, and at least one American company has secured concessions from the Spanish Government. In view of the national importance of the deposits, the Spanish Government is taking measures for supervising them, if not for exploiting them. Because of the small quantity of potash salts available for use in Spain, their export is forbidden for the time being.

When the potential supplies in the ground near Barcelona appear on the market there should be a considerable quantity for export in excess of the Spanish requirements. Though the consumption is small in Spain compared with the United States, it is increasing, especially as a fertilizer.

CHILE.[1]

Potash salts were discovered many years ago in Chile, but for some reason they have attracted little attention. They occur in Pintados and Bella Vista lakes, in the province of Tarapacá, not more than 3 miles from the railroad that runs from Iquique to Lagunas. The potash occurs over an area of 10,000 acres as the chloride in a saline crust and samples have been found containing from 3 to 36 per cent. The crust is not very thick (about 8 inches) and has been formed by the evaporation of an underlying bittern. A calculation has been made that the salt beds contain more than 2,000,000 tons of potassium chloride. The absence of magnesium salts, bromides, and iodides is noteworthy.

NITRATES.

Many reports of occurrences of nitrate that have come to hand during the year have been collected by Hoyt S. Gale, and some of the deposits have been examined by members of the United States Geological Survey. Most of them seem to be of the same type and of very doubtful commercial value. There are reports of deposits in Sulphur Spring Valley, Cochise County, and in Yavapai County, Ariz.; of cave earths high in nitrates in Madison County and Searcy County, Ark.; of deposits in Modoc County, San Diego County, and elsewhere in California; of a cave deposit containing nitrates in Oregon County, Mo.; of deposits in ledges in southern Nye County, in southeastern Churchill County, and in Humboldt County, Nev.; of deposits near Rodeo and Pratt (Grant County), about 60 miles "above" El Paso, in the foothills of the Guadalupe Mountains some 40 miles from Carlsbad, and about 18 miles north of Deming "up toward Cook's Peak," in New Mexico; of numerous deposits and considerable interest in locating claims about Burns and south of Riley in Harney County, at several places in Lake County, and also at localities in Malheur County, Oreg.; of deposits in Texas near Van Horn, San Saba, Presidio; and in Utah near Tucker and Thistle.

The nitrate deposits near Homedale, Idaho, were discovered in the spring of 1914 and in the fall of the same year they were examined by G. R. Mansfield, of the United States Geological Survey. They

[1] Salcedo, S., Eng. and Min. Jour., vol. 100, p. 218, Aug. 7, 1915.

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are located in and near the canyon of Sucker Creek, in Oregon, about 16 miles in a direct line southwest of Homedale, Idaho, and 26 miles by road, and also in the valley of Jump Creek, Idaho, 10 miles east of the occurrence on Sucker Creek.

Nitrate has been received by the Survey from the vicinity of Soldier, Blaine County, Idaho. The occurrence at Soldier has not been examined, but a study of the samples received suggests that the mode of occurrence is the same as at Homedale.

The nitrate occurs in rhyolite in veinlets, which also carry other salts. The saline matter does not constitute more than 1 per cent of the rock. How far the small veins extend into the rock can not be stated, but there seems to be little likelihood of any increase in richness with depth. According to Mansfield,[1]

> The Homedale and Soldier deposits may be taken as types of material from localities in many parts of the country, ranging all the way from Oregon to Texas, from which specimens have lately been received by the Geological Survey. The niter occurs on the surface and in cracks, forming in places rich veins in considerable quantity, but at no place yet examined has this superficial material seemed to lead to deposits extensive enough to have commercial value. Investigations should be continued in the hope that a commercially valuable deposit may be found. At the present time, however, the outlook is not very promising.

EXPLANATION OF THE TERM "POTASH."

To meet the numerous inquiries that have been addressed to the United States Geological Survey regarding the exact meaning of the terms "potash," "actual potash," and "potassium," the following explanation is given:

The element potassium, represented by the symbol K, is the basis of all potash salts or compounds. This substance is a metal; that is, it possesses metallic properties. To prevent rapid change it must be kept from air and water, with both of which it combines with great avidity. Combined with oxygen it forms potassium oxide, represented by the symbol K_2O, known as potassa, but popularly as "potash." In estimating the quantity of potassium in the different products of the Stassfurt deposits, this compound, K_2O, is employed as a standard, the object being to establish a basis of comparison for all potassium salts. Among chemists as well as laymen there has grown up the practice of using for this standard the term "potash." When only the term "potash" is used in speaking of potash products, it is understood to refer to the potassium oxide (K_2O) present. As a matter of fact, however, potash salts are not sold in the form K_2O, but as the sulphate or the chloride. By the term "potassium sulphate" is meant potassium (K) combined with the acid radicle of sulphuric acid (SO_4), or potassium oxide (K_2O) combined with sulphur trioxide (SO_3), making the compound K_2SO_4. By "potassium chloride" is meant potassium (K) combined with another element, chlorine (Cl), and represented by the formula KCl.

In the following table are given the percentages of the element potassium and also of the combination known as potash in or obtainable from the common potassium compounds and minerals:

[1] Nitrate deposits in southern Idaho and eastern Oregon: U. S. Geol. Survey Bull. 620, p. 32, 1915 (Bull 620-B).

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Potassium and "potash" in potassium compounds.

Name.	Symbol.	Percentage of potassium (K).	Chemical equivalent in terms of "potash" (K_2O).
Element:			
Potassium	K	100	120
Potassium salts or "potash salts":			
Potassium chloride (mineral sylvite)	KCl	52	63
Potassium muriate (same as chloride).			
Potassium sulphate	K_2SO_4	45	54
Potassium nitrate (saltpeter)	KNO_3	39	47
Potassium carbonate [a]	K_2CO_3	57	68
Potassium hydrate or caustic potash	KOH	70	84
Potassium cyanide	KCN	60	72
Stassfurt minerals:			
Carnallite	$KMgCl_3.6H_2O$	14	17
Kainite	$MgSO_4.KCl.3H_2O$	16	19
Sylvite (potassium chloride)	KCl	52	63

[a] The term "potash" is often applied to this compound.

SIMPLE TESTS FOR POTASH.

By W. B. Hicks.

DETECTION.

Principles.—Potassium is generally found in nature in solution, as soluble salts or saline residues, in organic substances, in alunite, and in silicate rocks and minerals. Simple methods for detecting and determining it are here described for the benefit of those who may be interested in making rough field tests. These tests have been used with good results by members of the United States Geological Survey and may be used successfully, it is believed, by any one with little or no experience in chemical manipulation. They depend on the fact that when a volatile potassium compound is heated in a flame it imparts a characteristic violet color to the flame. Though usually masked by the colors produced by other elements, especially sodium and calcium, the coloration due to potassium is readily seen and identified by observing the flame through a Merwin color screen.

Equipment.[1]—The equipment necessary for making the tests herein described consists of—

1. Lamp for volatilizing the potash compound. For this purpose an ordinary alcohol lamp with an asbestos wick will often suffice, but a gasoline or alcohol blast lamp, which requires no wick and which burns with a hot, nonluminous flame, gives far better results.
2. Platinum wire about 4 inches long. One end of the wire should be sealed into the end of a short glass rod to serve as a handle, and the opposite end should be bent into the form of a small loop.
3. Merwin color screen.[2]
4. Small beaker.
5. Hydrochloric acid.
6. Gypsum or calcium sulphate.

Procedure for waters and brines.—First clean the loop of platinum wire by dipping it in hydrochloric acid and igniting it until the flame

[1] The equipment here described, except the Merwin color screen, may be purchased very reasonably from most dealers in chemical and laboratory supplies.

[2] The Merwin color screen is manufactured and sold by G. M. Flint, 84 Wendell Street, Cambridge, Mass., for 25 cents. Hand spectroscopes may be used instead of the Merwin color screen. These may be had from most dealers in laboratory apparatus at $7 or more.

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is no longer colored. By means of the clean platinum loop remove a drop of the solution to be tested, carefully evaporate it to dryness by holding over the flame, finally ignite, and observe the color of the flame through the Merwin color screen. The best results are obtained by using a black background, holding the Merwin screen close up against the eyes, and looking through the central section of the screen. If potassium salts are present, the flame will appear reddish to reddish violet, and the intensity and duration of the color will give some idea as to the amount of potassium.

Procedure for soluble salts.—For detecting potassium in saline residues and soluble salts in general, as well as for detecting soluble potassium compounds in muds, clays, and ashes, proceed as follows: Dissolve a portion of the sample in a small quantity of water, allow the undissolved material to settle out, remove a drop of the clear solution by means of the loop of platinum wire, and test in the flame as just described for waters and brines.

In tests for alum and other sulphates the clear solution should be poured off from the insoluble residue and some hydrochloric acid added before making the test.

The water used in all such tests should be examined to see whether it contains potassium.

Procedure for organic substances.—The substance to be tested is first ignited or burned at as low a temperature as possible until only the ash remains. The ash is then tested for potassium according to the procedure just described for soluble salts.

Procedure for alunite.—Powder the sample to be tested and moisten it with hydrochloric acid. By means of the loop of platinum wire transfer a portion of the moistened powder to the flame, ignite, and and observe the color of the flame through the Merwin color screen. If potassium is present, the flame will appear deep reddish violet.

Emphasis should be placed on the fact that this procedure is a test for potassium and not necessarily for alunite. Other potash-bearing materials, especially leucite and glauconite, will give similar results with such treatment.

The following simple field test for the mineral alunite has been suggested by W. T. Schaller:[1] Boil the powdered sample with water or with hydrochloric acid for several minutes; after allowing the powder to settle, pour off the liquid and repeat the operation to insure the removal of all soluble sulphates. Dry the powder and heat to dull redness. Again boil in water and, after settling, pour off some of the clear liquid. To this add a small fragment or a solution of barium chloride. If the mineral is alunite a heavy white precipitate will form. To be sure that the water used in this test does not contain sulphate in solution, it should be tested with barium chloride, and if it gives a marked precipitate it can not be used.

For this test all that is required that was not included in the equipment for the detection of potassium is a little barium chloride, a small crucible in which to ignite the mineral, and a support for the crucible.

Procedure for silicate rocks and minerals.—In order to detect potassium in silicate rocks and minerals, such as feldspar, granite, leucite, rhyolite, glauconite, and sericite, powder the material finely, mix with an equal quantity of pure gypsum, and moisten the mix-

[1] U. S. Geol. Survey Bull. 511, p. 63, 1912.

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ture with dilute hydrochloric acid. By means of the loop of platinum wire, transfer a portion of the moist mixture to the flame, ignite, and observe the color of the flame through the Merwin color screen. The reddish violet color will be apparent if potassium is present.

Although with less satisfactory results, as a rule, the test may be carried out by mixing the material to be tested with either hydrochloric acid or gypsum alone.

ESTIMATION.[1]

Equipment.—A rough quantitative determination of the soluble potash in any salt may be made according to the method described below. To obtain even approximately correct results the conditions in making up the standard and in carrying out the actual determination on the unknown salt must be exactly the same.

The extra equipment required for this work is a small balance and a measuring cylinder. A hand spectroscope in place of the Merwin color screen will probably give better results.

Standardization.—Dissolve 1 gram of pure potassium chloride in 10 cubic centimeters of water and mix thoroughly. Remove a drop of the solution by means of a loop of platinum wire, dry carefully over the flame, ignite, and examine through the Merwin color screen. Gradually dilute the solution with measured amounts of pure water, mixing thoroughly and testing in the flame for potash the resultant solution after each addition of water, until the potassium flame can just be seen or disappears altogether. Record the exact volume of the solution at this point, and by repeated trials make sure of the correctness of the value. Designate this value for the standard solution by S.

Determination.—Dissolve 1 gram of the salt to be tested in 10 cubic centimeters of water and mix thoroughly. Remove a drop of the solution by means of a loop of platinum wire, dry carefully over the flame, ignite, and examine the color of the flame through a Merwin color screen. Now gradually dilute the solution with measured amounts of water, mixing thoroughly and testing in the flame the resultant solution after each addition of water, until the potassium flame can just be seen or disappears altogether. Record the exact volume of the solution at this point, and by repeated trials make sure of the correctness of the value. Designate this value for the unknown salt by X.

Calculations.—To obtain the percentage of potash expressed as potassium chloride in the unknown salt, divide the volume of the unknown solution at which the potassium flame could no longer be seen, designated X, by the volume of the standard solution at which the potassium flame could no longer be seen, designated S, and multiply the result by 100. In other words,

$$\text{Percentage of potassium chloride (KCl)} = \frac{\text{Volume found for unknown salt}}{\text{Volume found for standard salt}} \times 100 = \frac{100X}{S}$$

$$\text{Percentage of potash } (K_2O) = \frac{63.17X}{S}$$

$$\text{Percentage of potassium (K)} = \frac{52.44X}{S}$$

[1] For a description and bibliography of spectroscopic methods for the estimation of potassium, see Skinner, W. W., and Collins, W. D., U. S. Dept. Agr. Bur. Chem. Bull. 153.

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ASPHALT.

By JOHN D. NORTHROP.

INTRODUCTION.

In a broad sense the term natural asphalt may be used to denote all types of naturally occurring asphaltic substances that are employed in the arts and industries. It is so used in this chapter in reference to the asphaltic materials commercially mined or quarried in the United States. They comprise the native bitumens maltha, grahamite, and gilsonite; the so-called "pyrobitumen" elaterite; the bitumen impregnated rocks, sandstone, limestone, and shale; and the cerous hydrocarbon, ozokerite. The term "manufactured asphalt," as used in this chapter, includes both oil asphalt, a solid or semisolid by-product obtained in the distillation of asphaltic and semiasphaltic petroleum, and residual asphaltic oils or pitches, the viscous residues of the evaporation or distillation of petroleum of asphalt base to a point where all the burning oils and often some of the heavier distillates have been removed.

OCCURRENCE AND DISTRIBUTION.

The natural asphalts occur in the United States in three principal forms—(1) as viscous, semiliquid substances filling interstices and cavities in rock of almost every type, but found most abundantly in sand, sandstone, and limestone; (2) as viscous and semisolid tenaceous exudations from the earth, either directly from exposed bituminous rocks or from subterranean passages; (3) as solids in the form of veins or irregular bodies, cutting across or lying between layers or masses of rocks. Stratigraphically, the natural asphalts here considered occur in commercial quantities in or associated with sedimentary rocks of all ages from Ordovician to Pleistocene.

The distribution of the natural asphalts in the United States is wide, deposits having been found at numerous localities in fully a dozen States, though commercial production is now limited to only a few localities in California, Colorado, Kentucky, Texas, Oklahoma, and Utah.

The manufactured asphalt produced in the United States is obtained from certain grades of crude petroleum found in California, Texas, Louisiana, Oklahoma, Kansas, and Illinois, as well as from the heavier grades of Mexican crude, which are imported in ever increasing quantities for the manufacture of asphalt and asphalt products.

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GENERAL CONDITIONS.

The use of asphalt in the United States is steadily increasing, but the trend of the increase is toward a greater utilization of asphalt manufactured from crude petroleum rather than toward a more extensive development of the deposits of naturally occurring asphaltic materials. The factors that are bringing about this change in the asphalt industry are chiefly economic in their nature, now that the experimental stage in the utilization of the artificial product has been passed. The cost at which large refineries at tidewater or at interior points adjacent to the sources of asphaltic oil can supply an

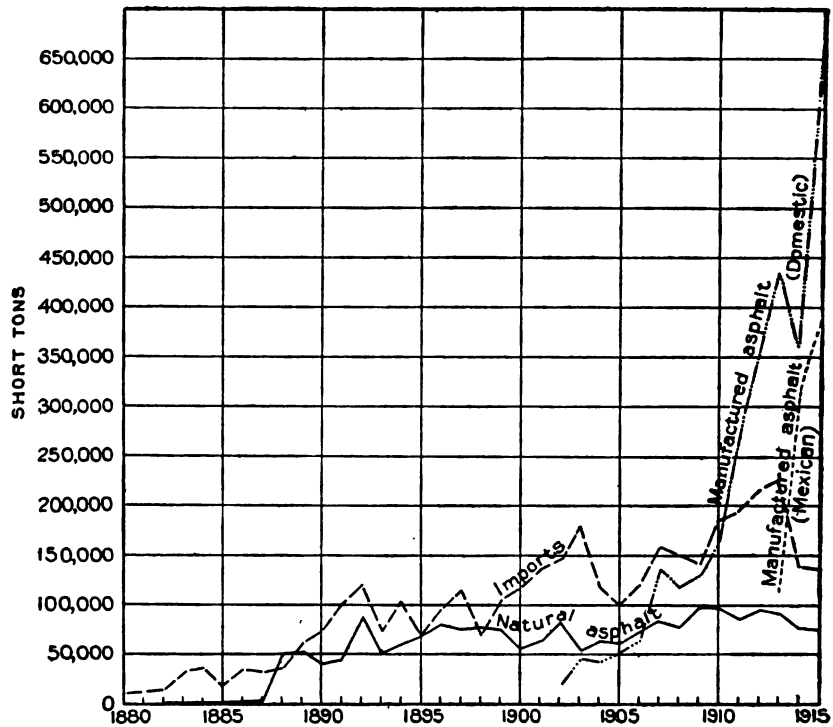

FIGURE 7.—Graphs showing marketed production of natural asphalt (all varieties) and of manufactured asphalt obtained from domestic and from Mexican petroleum, and imports of crude asphalt, in the United States, 1880–1915.

efficient substitute for the natural asphalts practically at the points of consumption is so low that only natural material of the highest grade, favorably situated with regard to quarrying, mining, and transportation, or of such a character as to be in demand for special purposes, can successfully compete with the manufactured material. In certain localities remote from sources of asphaltic petroleum but adjacent to deposits of suitable material in the form of asphaltic sandstone or limestone the natural asphalt retains its precedence.

The purer forms of solid or semisolid bitumen, such as gilsonite and grahamite, that are extensively utilized in the varnish and rubber industries and in electrical insulation supply a demand that

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is fairly constant and a market that has not been seriously invaded by man-made substitutes.

The accompanying diagram shows in graphic form the trend of the asphalt industry in the United States since 1880 and brings out more clearly than statistical tables the influence of manufactured asphalt on the demand for asphaltic materials from natural sources.

An interesting development in the asphalt industry was undertaken in 1915 by a company in Chicago looking to the utilization of the deposits of bitumen-impregnated shales found in western Colorado. After pulverization of the bitumen-rich shale and appropriate treatment with a synthetic resin a dark-brown molding compound is obtained, which hardens on drying and is reported to be of unusual strength and toughness and to possess properties of resisting heat, acids, and electricity to such an extent as to recommend its use in the manufacture of battery jars, steam-pump valves, chemical apparatus, table tops, and other products in the manufacture of which hard rubber or molding compounds having a wood filler are now used.

MARKETED PRODUCTION.

NATURAL ASPHALT.

The natural asphalt of all varieties sold at the sources of production in the United States in 1915 aggregated 75,751 short tons, valued at $526,490, a decrease of 4,137 tons, or 5 per cent, in quantity and of $15,633, or 2 per cent, in value from the corresponding totals in 1914. An analysis of the 1915 total shows that the decrease noted lies wholly in the quantity of bituminous rock marketed during the year, which amounted to 44,329 short tons in 1915, as compared with 51,071 short tons in 1914. A further analysis shows this decrease to be chiefly in the output of bituminous sandstone from California, though a small proportion is chargeable to Utah. That the net decrease for the entire country is no greater than recorded is due to increased output of bituminous rock from Texas and Oklahoma. As bituminous rock is utilized almost exclusively for paving and comes more intimately in competition with manufactured asphalts than the purer forms of bitumen that supply a variety of markets, the annually decreasing output of this type of asphalt may be ascribed directly to the keeness of this competition.

The statistics of output of the native bitumens, gilsonite and grahamite, in 1915 record slight increases over the output in 1914 and indicate a sufficient expansion of the home markets to compensate largely for the loss of foreign customers as a consequence of the European war.

The following table shows the combined output of all types of natural asphalt entering the markets from mines and quarries in the United States since 1882:

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Natural asphalt (including ozokerite) and bituminous rock sold at mines, 1882–1915.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1882	3,000	$10,500	1894	60,570	$353,400	1905	62,898	$305,242
1883	3,000	10,500	1895	68,163	348,281	1906	73,062	674,934
1884	3,000	10,500	1896	80,503	577,563	1907	85,913	928,381
1885	3,000	10,500	1897	75,945	664,632	1908	78,565	517,485
1886	3,500	14,000	1898	76,337	675,649	1909	99,061	572,846
1887	4,000	16,000	1899	75,085	553,904	1910	98,893	854,234
1888	50,472	190,500	1900	54,389	415,958	1911	87,074	817,250
1889	51,760	174,037	1901	63,134	555,335	1912	95,166	865,225
1890	41,016	216,666	1902	84,632	461,799	1913	92,604	750,713
1891	45,079	249,264	1903	55,068	483,282	1914	79,888	642,123
1892	87,710	453,375	1904	64,167	420,701	1915	75,751	526,490
1893	47,779	372,232						

MANUFACTURED ASPHALT.

The sales in 1915 of manufactured asphalt obtained from petroleum of domestic origin as reported to the Geological Survey amounted, at the sources of production, to 664,503 short tons, valued at $4,715,583, an average of $7.10 a ton, an increase of 303,820 tons, or 84 per cent, in quantity and of $1,698,614, or 56 per cent, in market value, but a decrease of $1.26, or 15 per cent, in average price per ton, as compared with the output in 1914. The output in 1915 includes 417,859 short tons, valued at $2,392,576, an average price of $5.73 a ton, of asphaltic oil used either for road sprinkling to allay dust or as a flux for softening harder bitumens, and 246,644 short tons, valued at $2,323,007, an average price of $9.42 a ton, of residual pitches, having a penetration less than 100 and utilized chiefly for paving. These statistics disclose increases of 246,412 short tons, or 144 per cent, in the output of road oils and fluxes and of 57,236 short tons, or 30 per cent, in the output of residual pitches, as compared with the statistics for 1914, and indicate clearly the ability of domestic sources to supply the growing demand for asphaltic materials needed in pavement and highway improvement, in the paint and varnish industries, and in the manufacture of roofing compounds, building papers, and rubber substitutes.

The increase in output of manufactured asphalt produced in the United States in 1915 from petroleum imported from Mexico was appreciable, but was much less than the corresponding increase in the output of this product from domestic crudes. The quantity of manufactured asphalt derived from Mexican petroleum at refineries in the United States in 1915 was 388,318 short tons, valued at $3,730,436, an average price of $9.61 a ton, at the refineries. This quantity includes 174,854 short tons, valued at $1,325,201, an average price of $7.58 a ton, of material classed as road oil and flux, and 213,464 short tons, valued at $2,405,235, an average price of $11.27 a ton of material classed as residual pitch.

The corresponding quantities in 1914 were—total output, 313,787 short tons; road oil and flux, 111,058 tons; and residual pitch, 202,729 tons.

The number of plants supplying the output of manufactured asphalt in the United States in 1915 was 39, of which 28 utilized exclusively petroleum of domestic origin, 9 utilized exclusively

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petroleum of Mexican origin, and 2 utilized petroleum from both sources.

The succeeding tables show by years and by sources of crude petroleum used the marketed production of manufactured asphalt in the United States since this phase of the asphalt industry became important.

Manufactured asphalt from domestic petroleum sold at refineries, 1902–1915.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1902	20,826	$303,249	1907	137,948	$1,898,108	1912	354,344	$3,755,506
1903	46,187	522,164	1908	119,817	1,540,396	1913	436,586	4,531,657
1904	44,406	459,135	1909	120,504	1,565,427	1914	360,683	3,016,989
1905	52,369	452,911	1910	161,187	2,225,833	1915	664,508	4,715,583
1906	64,907	615,406	1911	277,192	3,173,859			

Manufactured asphalt from Mexican petroleum sold at refineries, 1913–1915.

Year.	Quantity (short tons).	Value.
1913	114,437	$1,743,749
1914	313,787	4,131,153
1915	388,318	3,730,436

PRODUCTION BY CLASSES AND BY STATES.

The following tables record by principal varieties the sales of asphaltic material at the sources of production in the United States and show the distribution by States of the output of the natural varieties during the last five years:

Asphalt sold at mines and refineries, 1911–1915, by varieties.

Variety.	1911		1912		1913	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Bituminous rock	[a] 42,654	[a] $159,670	[a] 54,762	[a] $173,018	57,549	$173,764
Maltha	8,574	125,966	474	3,518		
Wurtzilite (elaterite)	610	30,500	[b] 8,452	[b] 115,620		
Gilsonite	30,236	486,114	31,478	573,069	35,055	576,949
Grahamite	5,000	15,000	(c)	(c)		
	87,074	817,250	95,166	865,225	92,604	750,713
Manufactured or oil asphalt [d]	277,192	3,173,859	354,344	3,755,506	436,586	4,531,657
	364,266	3,991,109	449,510	4,620,731	529,190	5,282,370

[a] Includes small output of mastic.
[b] Includes grahamite.
[c] Included in Wurtzilite.
[d] This item includes material derived from petroleum of domestic origin only.

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Asphalt sold at mines and refineries, 1911–1915, by varieties—Continued.

Variety.	1914		1915	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Bituminous rock	51,071	$162,622	44,329	$157,083
Maltha				
Wurtzilite (elaterite)	19,148	405,966	20,559	275,252
Gilsonite				
Grahamite	9,669	73,535	10,863	94,155
	79,888	642,123	75,751	526,490
Manufactured or oil asphalt [a]	360,683	3,016,969	664,503	4,715,583
	440,571	3,659,092	740,254	5,242,073

[a] This item includes material derived from petroleum of domestic origin only.

Natural asphalt sold at mines, 1911–1915, by States.

State.	1911		1912		1913	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
California	36,481	$220,580	36,741	$100,481	27,870	$69,825
Kentucky	(a)	(a)	[b] 10,145	[b] 46,032	[b] 17,465	[b] 60,131
Oklahoma	[c] 19,747	[c] 80,056	15,766	85,643	16,459	91,416
Texas			(d)	(d)	(d)	(d)
Utah	30,846	516,614	32,514	633,069	30,810	529,341
	87,074	817,250	95,166	865,225	92,604	750,713

State.	1914		1915	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
California	28,186	$77,810	17,794	$61,485
Kentucky	[b] 18,935	[b] 66,298	[b] 19,311	[b] 65,352
Oklahoma	9,669	73,535	16,907	118,351
Texas	(d)	(d)	(d)	(d)
Utah	23,098	424,480	[e] 21,739	[e] 281,302
	79,888	642,123	75,751	526,490

[a] Included in Oklahoma.
[b] Includes Texas.
[c] Includes Kentucky.
[d] Included in Kentucky.
[e] Includes Colorado.

CONDITIONS AND PRODUCTION IN THE PRINCIPAL PRODUCING STATES.

California.—The natural asphalt sold at the mines in California in 1915, which amounted to 17,794 short tons, valued at $3.46 a ton, consisted chiefly of bituminous sandstone from the well-known localities in Santa Cruz and San Luis Obispo counties. A small quantity of material classed as bituminous limestone was reported from Santa Cruz County. Compared with the annual yield in recent years this output shows a decrease that reflects strongly the influence of local competition by the manufactured product. The output of asphalt of the latter type in California was distributed in 1915 among 20 refineries and amounted to 238,917 short tons, valued at $1,516,979,

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or an average price of $6.35 a ton. Compared with the statistics for 1914 these figures show a decrease of 21,055 tons in quantity and of $1.55 in the average price per ton received for the manufactured asphalt marketed. The depressed condition of the crude petroleum market in California during the greater part of the year is believed to account largely for the lower price at which manufactured asphalt could be marketed in 1915 and, going a step further, also for the falling off in the local output of bituminous rock.

Of the output in 1915 of manufactured asphalt from California sources 78,200 short tons, valued at $309,147, or an average price of $3.95 a ton, were marketed for road oiling and fluxing, and 160,717 short tons, valued at $1,207,832, or an average of $7.52 a ton, comprised residual pitches marketed chiefly for pavement construction.

Colorado.—The return of Colorado to the ranks of asphalt-producing States was effected by the quarrying of a small quantity of bituminous shale in the western part of the State and its consumption in Chicago in experimental work, the nature of which is described on page 137 of this report. The outlook for a more extensive development of the deposits in 1916 is reported as encouraging.

Kentucky.—The contribution of Kentucky to the asphalt industry in 1915 consisted of bituminous sandstone, utilized for road surfacing, which was supplied by a single quarry in Edmonson County. The output in 1915, which was slightly less than in 1914, is included with that of Texas, to avoid disclosing individual returns.

Oklahoma.—The output in 1915 of natural asphalt in Oklahoma, which comprised the variety grahamite from two localities in Pushmataha County and bituminous sandstone from one locality in Pontotoc County and one locality in Murray County, was decidedly greater than in 1914, the increase being credited in part to grahamite but largely to bituminous sandstone, as a consequence of the opening of a quarry near Ada in Pontotoc County in May. The grahamite produced in Oklahoma is utilized in the manufacture of roofing materials and the bituminous sandstone quarried is absorbed in the paving industry, being used in 1915 in various cities in Oklahoma, Texas, Missouri, and Kansas.

Crude petroleum produced in Oklahoma and Kansas contributed largely to the output of manufactured asphalt in 1915 through refineries located in Illinois and Indiana.

Texas.—Natural asphalt was quarried in Texas in 1915 at only one locality, in Uvalde County. The output of bituminous rock from this source was slightly greater than in 1914. Statistics of marketed production of natural asphalt in Texas are included with the output of Kentucky.

The output in 1915 of manufactured asphalt from Texas and Louisiana petroleum amounted to 100,813 short tons, valued at $1,279,757, or an average price of $12.69 a ton at the four contributing refineries, and included 46,658 short tons of road asphalt and fluxing material, valued at an average price of $1.74 a ton, and 54,155 tons of residual pitch, valued at an average price of $14.38 a ton.

Louisiana.—A small quantity of manufactured asphalt was refined in Texas from crude petroleum produced in Louisiana.

Utah.—The natural hard asphalts, gilsonite and elaterite produced in Utah supply a demand for hydrocarbon material used in the man-

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ufacture of paints, japans, lacquers, varnishes, ready roofing, and rubber compounds, which caused an increase in output of about 7 per cent in 1915. The output of bituminous sandstone in this State, which is utilized in the local paving industry, decreased notably as compared with 1914, the smaller output in 1915 being ascribed by A. V. Taylor [a] to the failure of the State legislature to enact legislation that would permit the assessment of the cost of paving street intersections against abutting property instead of requiring that such paving shall be paid from municipal funds, which are restricted by tax limitations and are rarely more than sufficient for current expenses.

Illinois.—The contribution to the asphalt industry in Illinois in 1915, as in previous years, consisted in supplying crude petroleum for the manufacture of asphalt to three refineries, which had a combined output of 188,575 short tons, valued at the refineries at $1,041,378, the greater part of which was marketed as road asphalt and flux.

Other States.—In addition to the sources of asphalt previously mentioned the following States, containing no commercially developed sources of raw material, contributed to the output of manufactured asphalt in 1915 through refineries treating asphaltic oils produced in adjacent States or imported from Mexico, namely, Indiana, Maryland, New Jersey, Ohio, and Pennsylvania.

Philippine Islands.—Detailed information concerning the distribution, character, geology, and mode of occurrence of the deposits of native bitumen and bituminous rock in the island of Leyte is contained in a report by Mr. Wallace E. Pratt,[b] of the Philippine Bureau of Science, the scope of which is too broad to permit a satisfactory abstract.

IMPORTS.

ASPHALT.

Asphalt imported for consumption in the United States, 1911–1915.

Year.	Crude.		Dried or advanced.		Bituminous limestone.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1911	167,681	$572,198	20,461	$184,954	8,180	$23,468	196,322	$780,236
1912	193,645	726,345	20,707	177,992	3,976	15,808	218,328	921,145
1913	[c] 207,033	738,452	[d] 14,750	133,336	6,395	38,823	228,178	910,611
1914	137,352	664,558	.....	.....	1,705	11,060	139,057	675,618
1915	135,276	661,356	.....	.....	2,976	19,001	138,252	680,357

[a] Taylor, A. V., Oil and hydrocarbons: Salt Lake Min. Rev., vol. 17, No. 18, p. 86, Jan. 15, 1916.
[b] Petroleum and residual bitumens in Leyte: Philippine Jour. Sci., vol. 10, Sec. A, No. 4, July, 1915.
[c] Includes dried or advanced asphalt for last three months of 1913.
[d] Last three months of 1913 included in crude asphalt.

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Asphalt imported for consumption in the United States, 1914–1915, by countries.

Imported from—	1914		1915	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Europe:				
France	100	$1,317	.....	.....
Germany	1,354	10,856	658	$4,854
Italy	247	1,477	492	3,438
Switzerland	620	3,706	200	1,637
England	628	6,269	774	9,801
North America:				
Canada	31	200	35	708
Mexico	140	2,048	56	755
West Indies—				
Barbados	71	6,592	64	6,426
Trinidad and Tobago	61,708	334,635	92,107	498,900
Cuba	458	11,407	391	9,243
South America:				
Colombia	85	5,047	.....	.....
Venezuela	58,755	295,765	28,659	144,595
Asia:				
Turkey	17	3,429	.....	.....
	124,214	682,748	123,436	680,357
Equivalent in short tons	139,057	.....	138,252	.....

In addition to the imports of unmanufactured asphalt in 1915 asphalt products aggregating $681 in declared value were imported for consumption during the year.

The foregoing tables show that the bulk of the asphaltic material obtained by consumers in the United States from foreign sources consists of crude asphalt from Trinidad and Venezuela and indicate that the Trinidad product is more in demand than the Bermudez grades.

OZOKERITE.

The demand in the United States for the cerous hydrocarbon, ozokerite or native paraffin wax has increased notably since the foreign sources of supply were cut off as a consequence of the European war. In May, 1914, the wholesale market prices for ozokerite in New York ranged from 22 cents a pound for the crude brown varieties to 30 cents a pound for crude green. In May, 1916, two years later, corresponding quotations ranged from 45 cents a pound for crude brown to 60 cents a pound for crude green, with only a small quantity available from foreign dealers who had accumulated stocks of ozokerite before the war.

As a consequence of this marked advance in price, renewed interest in the development of the latent ozokerite deposits in Utah and Wasatch counties, Utah, has been aroused, and the Survey is reliably informed that domestic ozokerite will be on the markets before the end of 1916.

An indication of the extent of the demand for ozokerite in this country and of the inability of American consumers to procure an adequate supply of this mineral from foreign sources is found in the following table:

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Mineral wax, chiefly ozokerite, imported for consumption in the United States, 1910–1915.

Year.	Quantity (pounds).	Declared value.	
		Total.	Per pound.
1910	7,983,377	$606,651	$0.076
1911	4,472,708	388,461	.087
1912	6,352,003	488,804	.077
1913	7,141,514	549,992	.077
1914	8,191,529	498,695	.061
1915	2,795,256	210,019	.075

ICHTHYOL.

For a number of years the United States has imported successively greater quantities of a peculiar form of asphaltic material, which, after appropriate chemical treatment, is employed as an antiseptic and alterative medicament under the name ichthyol. The crude material from which it is derived is a bituminous rock, filled with fossil fish that is found in quantity at several localities near Seefeld, in the Austrian Tyrol.

At the outbreak of the European war direct importations of this substance were no longer possible and the subsequent supply, like that of ozokerite, has been furnished by foreign dealers who had accumulated stocks of ichthyol prior to August, 1914. The table below indicates the growth of the domestic market for this pharmaceutical product and shows the inadequacy of the foreign supply that was available in 1915 to meet the needs of American consumers.

As there are no known deposits in the United States of asphaltic material of the peculiar type from which ichthyol is derived, it is a satisfaction to know that American chemists have solved the problem of supplying the domestic needs in this regard and that favorably recommended substitutes for ichthyol, prepared from domestic materials by synthetic methods, are now available in the markets.

Ichthyol imported for consumption, 1910–1915.

Year.	Quantity (pounds.)	Value.
1910	24,663	$35,111
1911	42,589	65,715
1912	51,502	69,670
1913	58,485	83,034
1914	61,416	86,415
1915	24,921	28,560

EXPORTS.

The foreign trade of the United States in asphalt and asphalt products expanded slightly in 1915 as compared with 1914, the quantity of manufactured asphalt exported increasing from 37,246 long tons in 1914 to 38,203 long tons in 1915 and the declared value of the asphalt products sent out increasing from $401,182 in 1914 to $438,685 in 1915. The principal increase in foreign shipments of unmanufactured asphalt was to England and to Canada, whereas

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appreciable decrease was apparent in the exports to Germany, Cuba, and Chile.

The following tables have been compiled from the records of the Bureau of Foreign and Domestic Commerce.

Asphalt exported from the United States, 1912–1915.

Year.	Unmanufactured.		Manufactures (value).	Total value.
	Quantity (long tons).	Value.		
1912	39,915	$886,678	$467,959	$1,354,637
1913	58,550	1,267,625	411,786	1,679,411
1914	37,246	845,838	401,182	1,247,020
1915	38,203	735,952	438,685	1,174,637

Asphalt exported from the United States, 1914–1915, by countries.

Exported to—	1914			1915		
	Unmanufactured.		Manufactures (value).	Unmanufactured.		Manufactures (value).
	Quantity (long tons).	Value.		Quantity (long tons).	Value.	
Europe:						
Austria-Hungary	412	$8,886				
Belgium	416	9,596	$405			
Denmark	130	2,191		63	$2,533	$267
France	559	14,304	162	340	9,915	5,678
Germany	4,495	106,553	23,179			
Italy	21	494	2,703			4,058
Netherlands	1,888	46,704		3	93	93
Norway				3	80	
Roumania			3,151			
Russia in Europe	5	101		50	3,956	
Spain	120	2,419	11,162	125	2,787	10,263
Sweden			238			1,444
Switzerland						136
England	3,585	76,651	41,401	8,782	203,160	66,920
Scotland	177	3,648		451	9,964	1,885
Ireland	40	806	4,684	98	5,214	4,315
North America:						
Bermuda						3
Canada	16,275	322,969	284,460	25,868	438,696	188,634
Central American States—						
Costa Rica			12			
Guatemala			74			79
Honduras			7			196
Nicaragua						20
Panama	217	5,232	7,230	9	216	10,085
Mexico	32	880	2,903	35	800	4,024
Newfoundland			72			
West Indies—						
Cuba	4,139	100,999	2,489	1,445	32,280	3,6·2
Dominican Republic			40	11	208	120
British—						
Jamaica			24			40
Other British Indies						14
South America:						
Argentina	1,775	47,445	65	556	12,868	18,453
Bolivia	2	40				
Brazil	1,068	38,808	1,942	168	7,353	33,075
Chile	1,384	42,858	1,877	8	280	17,172
Columbia				2	100	267
British Guiana	2	33				42
Ecuador	5	208				36
Peru			346			
Uruguay				5	154	961
Venezuela			102			55

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Asphalt exported from the United States, 1914–1915, by countries—Continued.

Exported to—	1914			1915		
	Unmanufactured.		Manufactures (value).	Unmanufactured.		Manufactures (value).
	Quantity (long tons).	Value.		Quantity (long tons).	Value.	
Asia:						
China	55	$1,218	$57	16	$454	$11,532
China, territory leased to Japan	39	906				
East Indies—						
British India			1,348			3,714
Straits Settlements			173			1,599
Other British			120			1,080
Dutch			61			1,500
French						321
Hongkong			71			4,427
Japan	24	577	4,312			6,278
Siam			120			591
Oceania:						
British—						
Australia	264	8,931	1,653	134	3,981	10,699
New Zealand	4	115	1,509			7,965
German						288
Philippine Islands	40	759	2,803			16,464
Africa:						
British South Africa	72	1,474	200	8	200	200
German	1	33				
Egypt			27			
Portuguese Africa				23	575	
	37,246	845,838	401,182	38,203	735,952	438,685
Equivalent in short tons	41,716			42,787		

CONSUMPTION.

The quantity of asphaltic material actually consumed in the United States is not susceptible of accurate determination. The sum of the quantity marketed from domestic sources and the quantity imported less the quantity exported in a given year provides, however, an approximation of the quantity consumed that is not without value in the absence of more specific data. On this basis the consumption of asphaltic material, including both natural and manufactured varieties, in 1915 amounted to 1,224,037 short tons, as compared with 851,699 short tons in 1914, computed by the same method.

The principal use of asphaltic material in the United States is for highway and pavement construction and maintenance, the country-wide movement toward better roads and quieter and more sanitary pavements creating a demand for all types of asphalt that shows a steady annual increase. Data are not available as to the quantity of asphalt utilized in road and pavement construction, but the following statistics[1] of asphalt pavement (including both natural and manufactured asphalt) constructed in a number of typical cities in 1915 indicate the general popularity of asphalt for street improvement purposes:

[1] Engineering and Contracting, vol. 45, No 14, Apr. 5, 1916.

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Asphalt pavement constructed in 1915 in various cities.

	Square yards.
Massachusetts:	
Boston	33,928
Springfield	14,271
Connecticut:	
Derby	1,005
Hartford	29,873
New Haven	50,380
Stamford	20,814
Rhode Island:	
Providence	27,628
New York:	
Albany	42,452
Geneva	[1] 17,469
New York (Bronx)	51,169
New York (Richmond)	142,347
Schenectady	133,365
Syracuse	82,775
New Jersey:	
Camden	31,796
Harrison	4,241
Jersey City	2,974
Passaic	35,932
Pennsylvania:	
Allentown	42,975
Erie	20,761
Harrisburg	38,551
Johnstown	25,127
Philadelphia	327,790
Pittsburgh	[2] 14,927
Pittsburgh	25,378
Scranton	28,114
Wilkes-Barre	40,024
York	20,597
Maryland:	
Baltimore	239,912
Ohio:	
Cincinnati	29,732
Columbus	12,269
Lakewood	24,500
Lakewood	11,207
Toledo	61,285
Urbana	11,600
Youngstown	8,890
Indiana:	
Fort Wayne	39,003
Indianapolis	311,940
Richmond	18,748
South Bend	7,760
Wabash	10,964
Illinois:	
Chicago	854,681
Moline	28,088
Peoria	[1] 28,645
Rock Island	13,932
Michigan:	
Bay City	31,491
Detroit	26,476
Flint	73,800
Michigan—Continued.	
Grand Rapids	8,100
Saginaw	25,256
Wisconsin:	
Appleton	20,000
Beloit	55,000
Milwaukee	227,833
Minnesota:	
Duluth	4,757
St. Paul	10,012
Iowa:	
Cedar Falls	45,857
Davenport	4,805
Fort Dodge	23,445
Waterloo	5,100
Missouri:	
Kansas City	72,584
District of Columbia:	
Washington	35,745
West Virginia:	
Charleston	1,317
North Carolina:	
Concord	13,897
Durham	2,052
Greensboro	48,100
South Carolina:	
Anderson	70,000
Charlotte	37,144
Columbia	51,532
Greenville	10,000
Kentucky:	
Lexington	27,170
Tennessee:	
Chattanooga	[1] 13,075
Mississippi:	
Vicksburg	81,044
Louisiana:	
New Orleans	37,820
Oklahoma:	
Ardmore	1,800
Tulsa	60,000
Texas:	
Dallas	[3] 35,190
Hillsboro	[3] 9,155
Utah:	
Salt Lake City	6,549
Salt Lake City	[3] 66,165
California:	
Long Beach	134,017
Oakland	57,649
Pomona	150,611
Vallejo	[3] 11,730
Washington:	
Everett	16,301
Oregon:	
Eugene	14,438
Portland	4,285

[1] Resurfacing. [2] New work. [3] Rock asphalt.

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ASPHALT INDUSTRY IN PRINCIPAL COUNTRIES.

The following table shows the output of natural asphalt (all forms) in the principal producing countries, by calendar years, except as otherwise stated, from 1906 to 1915, inclusive, as far as reliable statistics are available:

Asphalt and bituminous rock produced in principal producing countries, 1906–1915.

Year.	United States.		Trinidad.[a]		Germany.		Cuba.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1906	73,062	$674,934	150,373	$832,964	129,388	$268,631	5,717	$26,605
1907	85,913	928,381	171,271	832,274	139,507	264,494	5,571	37,594
1908	78,565	517,485	143,552	403,023	98,088	188,334	6,875	31,574
1909	99,061	572,846	159,416	459,446	85,446	176,897	11,900	48,246
1910	98,893	854,234	157,120	421,419	89,491	152,565	2,320	13,635
1911	87,074	817,250	[b] 201,284	[c] 494,000	90,256	154,938	3,638	21,928
1912	95,166	865,225	[b] 212,236	[c] 521,000	106,950	200,743	17,260	87,500
1913	92,604	750,713	[b] 257,635	[c] 633,000	.....	.....	[b] 1,749	30,935
1914	79,888	642,123	[b] 163,076	[c] 400,411	.....	.....	[b] 969	19,491
1915	75,751	526,490	.....	.....	.....	.....	[d] 149	3,564

Year.	France.		Italy.[e]		Spain.		Japan.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1906	216,405	$345,599	144,802	$349,926	8,587	$17,130	43	$3,572
1907	195,136	330,065	178,127	442,014	9,057	16,001	644	5,436
1908	188,616	264,188	148,433	368,306	13,635	24,084	2,650	25,564
1909	186,208	260,161	123,361	305,159	5,822	10,282	4,614	45,205
1910	187,085	277,210	179,261	452,911	7,072	18,308	536	29,004
1911	.....	.....	207,926	501,550	[f] 4,124	8,754	1,389	13,728
1912	.....	.....	200,560	581,383	5,938	13,008	3,199	32,518
1913	.....	.....	188,601	521,398	.....	.....	.....	.....
1914	.....	.....	.....	.....	.....	.....	.....	.....
1915	.....	.....	.....	.....	.....	.....	.....	.....

Year.	Austria-Hungary.		Russia.		Venezuela.		Mexico.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1906	10,633	$778,781	[g] 12,517	$110,294	[b] 22,128	$98,250	1,531	$17,174
1907	11,335	727,892	[g] 14,116	101,705	[b] 37,637	167,938	4,945	182,265
1908	12,239	768,162	[g] 24,961	491,302	[b] 31,539	141,912	5,811	330,903
1909	11,179	663,246	[h] 2,665	4,599	[b] 37,292	180,061	6,031	106,494
1910	9,070	702,022	[h] 27,544	176,518	[b] 31,890	[e] 151,000	3,140	39,681
1911	[h] 8,312	652,603	.....	.....	[b] 50,163	[c] 238,000	8,912	125,322
1912	[h] 11,439	664,778	.....	.....	[b] 65,875	[c] 312,000	33,611	462,230
1913	.....	.....	.....	.....	[b] 83,825	[c] 400,000	.....	.....
1914	.....	.....	.....	.....	[b] 44,590	.....	.....	.....
1915	.....	.....	.....	.....	[b] 28,526	.....	.....	.....

[a] Includes small quantity of manjak, produced in Barbados.
[b] Exports.
[c] Estimated.
[d] Exports for six months.
[e] Only about 7 per cent of the quantity given represents asphalt, the remainder being bituminous sandstone and limestone.
[f] In addition 6,306 tons of bituminous rock were produced, no value being reported.
[g] Includes mineral pitch.
[h] Includes ozokerite.

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TRINIDAD.

The effects of the European war on the asphalt industry of Trinidad are plainly shown in the accompanying table, which is presented through the courtesy of the Barber Asphalt Paving Co. European demand for Trinidad asphalt, which has averaged about the same as that of the United States prior to 1915, fell off more than 57,000 long tons in that year as compared with 1914. This loss was, however, largely made up by increased shipments to the United States, which required nearly 49,000 long tons more in 1915 than in 1914, so that the net decrease in asphalt exports was only about 9,500 long tons, or 6.5 per cent of the exports in 1914.

Asphalt exported from Trinidad, 1911–1915, in long tons.

Year.[a]	To United States.			To Europe.			To other countries.			Grand total.
	Lake.	Land.	Total.	Lake.	Land.	Total.	Lake.	Land.	Total.	
1911	103,590	8,040	111,630	67,105	.....	67,105	983	.....	983	179,718
1912	95,111	8,600	103,711	85,299	.....	85,299	486	.....	486	189,496
1913	123,873	1,400	125,273	104,153	.....	104,153	605	.....	605	230,031
1914	67,357	2,950	70,307	75,297	.....	75,297	.....	.....	.....	145,604
1915	118,001	1,250	119,251	18,025	.....	18,025	.....	.....	.....	136,026

[a] Ending Jan. 31 of year succeeding.

VENEZUELA.

That the European war has adversely affected the asphalt industry of Venezuela is shown in the following statement, dated March 4, 1916, of United States Consul Homer Brett, at La Guaira, contained in Commerce Reports, issue of March 29, 1916:

Shipments of asphalt from Cristobal Colon are greatly cramped by the high ocean freights now prevailing. Before the war one steamer weekly was dispatched, while only one a month is going forward at present.

Of further interest as indicating a possible future source of asphalt in Venezuela this report notes the issuance of a lease to Señor Guillermo Pimentel Troconis on a mining claim near the city of Puerto Cabello for the production of asphalt, petroleum, etc.

Supplemental information concerning this contract is to the effect that the area involved is 494 acres, that the term of the lease is 25 years, that a certain royalty per ton of product exploited is required in addition to the ground rental, that machinery for development may be imported free of duty but reverts to the Government at the expiration of the lease, and that during the period of exploitation the Government shall have a preferential right to purchase such quantities of asphalt and petroleum as it may require at a discount of 20 per cent from the market price.

CUBA.

Little is being done in the way of development of the abundant deposits of asphalt in the island of Cuba. In order to understand this condition of inactivity it is only necessary to consider the geographical position of Cuba, adjacent not only to the sources of the purest natural asphalt known, in Trinidad and Venezuela, but to

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the large sources of manufactured asphalt in the United States and Mexico.

The following table shows the trend of the Cuban asphalt industry in the last five years:

Asphalt exported from Cuba, 1911–1915.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1911	3,248	$21,629	1914	865	$19,491
1912	15,410	86,303	1915 (six months)	133	3,564
1913	1,562	30,935			

CANADA.

Interest in the vast undeveloped sources of bituminous sand in northern Alberta, recently described by S. C. Ells,[1] received a marked impetus in 1915 as a result of the successful completion in Edmonton of a section of pavement laid with this material and of the rapid progress made on construction work on the Alberta & Great Waterways Railway from Edmonton to McMurray, which, it is expected, will provide an outlet to markets for this type of asphalt before the end of 1916.

[1] The bituminous sands of northern Alberta: Canada Dept. Mines, Mines Branch, Rept. 281, 1914.

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GYPSUM.[1]

By R. W. Stone.

PRODUCTION.

Although the output of gypsum mined decreased in 1915, the decrease was only a little more than 1 per cent, and the decrease in value of products marketed was only about 4 per cent. As a matter of fact, the quantity mined exceeded that of all previous years except three, 1912, 1913, and 1914, as shown by the accompanying table:

Crude gypsum mined in the United States, 1880–1915.

	Short tons.		Short tons.		Short tons.
1880	90,000	1892	256,259	1904	940,917
1881	85,000	1893	253,615	1905	1,043,202
1882	100,000	1894	239,312	1906	1,540,585
1883	90,000	1895	265,503	1907	1,751,748
1884	90,000	1896	224,254	1908	1,721,829
1885	90,405	1897	288,982	1909	2,252,785
1886	95,250	1898	291,638	1910	2,379,057
1887	95,000	1899	486,235	1911	2,323,970
1888	110,000	1900	594,462	1912	2,500,757
1889	267,769	1901	633,791	1913	2,599,508
1890	182,995	1902	816,478	1914	2,476,465
1891	208,126	1903	1,041,704	1915	2,447,611

There was an increase in the quantity of gypsum sold without calcining for use in Portland cement but a decrease in its value, due to a decline in the price per ton. There was also an unusual increase in the quantity sold as land plaster, and the decrease in the average price per ton was thus more than counterbalanced, so that there was an increase in the value as well.

The quantity of calcined gypsum sold in 1915 was about 42,000 tons less than in 1914 but greater than in any year prior to 1912. There was a decrease of a few cents in average price per ton in most classes of gypsum products.

Gypsum was produced in 18 States and in Alaska. New York was the largest producer of raw gypsum, Iowa ranked second, and Michigan was third. Sales of gypsum products are credited to Illinois, Minnesota, Washington, and Wisconsin, although these States are not producers. This is the necessary result of the trend of the gypsum industry toward assembling calcined gypsum, retarder, fiber, and sand, and preparing plasters for the market at local mixing mills, from which they may be more readily and economically distributed to the trade territory. Sales reported to the Survey from mixing plants and warehouses are credited to the State in which the plants are located.

[1] The statistical data in this report were compiled by Miss L. M. Jones, statistical clerk.

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The following tables summarize the gypsum industry in 1914 and 1915:

Gypsum marketed in the United States, 1914 and 1915, by States and uses.

1914.

State.	Number of mills reporting.	Total quantity mined (short tons).	Sold without calcining.				Sold as calcined plaster.		Total value.
			Ground for land plaster.		For Portland cement, paint, and other purposes.		Quantity (short tons).	Value.	
			Quantity (short tons).	Value.	Quantity (short tons).	Value.			
Alaska, Arizona, Colorado, Illinois,[a] Minnesota,[a] Montana, Nevada, New Mexico, Oregon, South Dakota, Virginia, Washington,[a] Wisconsin[a]	15	358,363	14,193	$34,922	47,301	$122,741	238,497	$1,162,584	$1,320,247
California	9	27,376	5,199	14,334	12,921	30,710	24,787	139,842	184,886
Iowa	5	480,404	12,251	14,920	52,934	45,566	335,065	1,260,971	1,321,457
Kansas	4	80,774	(b)	(b)	[b] 23,796	[b] 22,531	47,877	255,812	278,343
Michigan	8	393,006	9,322	10,761	51,905	40,481	249,648	654,599	705,841
New York	7	523,368	6,540	12,535	172,279	247,307	279,449	977,350	1,237,192
Ohio	4	265,091	(b)	(b)	[b] 8,189	[b] 13,156	220,126	760,257	773,413
Oklahoma	6	113,103	(c)	(c)	(c)	(c)	[c] 91,419	[c] 312,856	312,856
Texas	4	158,814			(c)	(c)	[c] 133,478	[c] 490,937	490,937
Utah	3	44,950	(b)	(b)	[b] 7,639	[b] 14,741	33,401	169,880	184,621
Wyoming	3	31,216					21,537	86,196	86,196
	68	2,476,465	52,945	97,716	390,742	549,083	1,656,066	6,249,190	6,895,989

1915.

Alaska, Arizona, Colorado, Illinois,[a] Minnesota,[a] Montana, Nevada, New Mexico, Oregon, South Dakota, Virginia, Washington,[a] Wisconsin[a]	16	319,164	25,089	$52,596	49,025	$108,746	215,492	$1,073,957	$1,235,299
California	3	32,559	(c)	(c)	(c)	(c)	[c] 29,060	[c] 113,863	113,863
Iowa	5	495,860	12,086	11,422	59,823	48,508	335,057	1,218,198	1,278,128
Kansas	4	60,919	(b)	(b)	[b] 17,332	[b] 14,887	40,634	235,127	250,014
Michigan	8	389,791	(b)	(b)	[b] 69,572	[b] 63,236	245,484	623,073	686,309
New York	11	540,914	9,262	17,463	175,255	251,004	293,870	999,239	1,267,706
Ohio	4	269,036	4,030	6,485	5,131	6,485	217,811	759,550	772,520
Oklahoma	5	110,790	(b)	(b)	[b] 17,580	[b] 15,784	73,348	278,446	294,230
Texas	5	176,306	(c)	(c)	(c)	(c)	[c] 148,138	[c] 519,879	519,879
Utah	3	23,445	(c)	(c)	(c)	(c)	[c] 20,541	[c] 75,835	75,835
Wyoming	5	38,827					25,749	103,110	103,110
	69	2,447,611	69,256	122,714	406,393	528,161	1,613,720	5,946,018	6,596,893

[a] No crude gypsum produced in the State.
[b] Some land plaster included with gypsum sold for Portland cement, etc.
[c] Some crude gypsum included with calcined plaster.

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Gypsum marketed in the United States, 1911–1915, by uses.

Year.	Sold without calcining.													
	For Portland cement.			As land plaster.			For paint material.			For other purposes.			Total.		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
1911	327,953	$484,373	$1.48	52,880	$97,573	$1.85	(a)	(a)	.....	a 6,647	$7,533	$1.13	387,480	$589,479	$1.52
1912	382,952	509,400	1.33	53,065	107,058	2.02	(a)	(a)	.....	a 5,591	7,064	1.26	441,608	623,522	1.41
1913	408,221	600,913	1.47	54,815	95,953	1.75	(a)	(a)	.....	d 100	200	2.00	463,136	697,066	1.51
1914	b 390,742	b 549,083	1.41	52,945	97,716	1.85	(b)	(b)	.....	.....	.....	.....	443,687	646,799	1.46
1915	b 406,393	b 528,161	1.30	69,256	122,714	1.77	(b)	(b)	.....	.....	.....	.....	475,649	650,875	1.37

Year.	Sold calcined.													
	As plaster of Paris, wall plaster, Keenes cement, etc.			For dental plaster.			To glass factories.			For Portland cement and other purposes.			Total.		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
1911	1,523,263	$5,678,453	$3.73	413	$2,612	$6.32	33,472	$80,220	$2.40	41,270	$111,271	$2.70	1,598,418	$5,872,556	$3.67
1912	1,678,417	5,805,999	3.46	c 3,190	15,564	4.88	24,159	52,741	2.18	25,908	66,082	2.55	1,731,674	5,940,386	3.43
1913	1,680,157	5,858,785	3.49	861	4,168	4.84	10,942	21,797	1.99	81,889	193,006	2.36	1,773,849	6,077,756	3.43
1914	1,565,937	6,038,777	3.86	641	3,374	5.26	(d)	(d)	.....	d 89,488	207,039	2.31	1,656,066	6,249,190	3.77
1915	1,520,308	5,776,826	3.80	534	2,376	4.45	11,861	26,620	2.25	81,017	140,196	1.73	1,613,720	5,946,018	3.68

a Paint material included under "For other purposes."
b Small quantity of paint material included with gypsum sold for Portland cement.
c Includes some casting plaster.
d Calcined gypsum sold to glass factories included under "For Portland cement and other purposes."

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IMPORTS.

Gypsum imported into the United States comes almost wholly from Nova Scotia and New Brunswick and enters the ports of the New England and North Atlantic States, over one-half of it entering the port of New York. The value of imports from 1889 to 1898 averaged about one-third of the value of domestic production, but since 1899 the proportionate value of imports has become very small and seems to be steadily decreasing. It amounted to less than one-twelfth of the value of the domestic production in 1913, a little more than one-sixteenth in 1914, and somewhat more than one-seventeenth in 1915.

Gypsum imported and entered for consumption in the United States, 1911–1915.[a]

Year.	Unground.		Ground or calcined.		Value of manufactured plaster of Paris.	Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.		
1911	389,874	$413,119	388	$3,353	$34,334	$450,806
1912	412,697	430,183	3,702	19,709	38,589	488,481
1913	447,383	473,594	4,542	31,277	52,051	556,922
1914	369,214	392,118	3,559	27,931	24,792	444,841
1915	336,856	356,791	5,749	22,873	10,095	389,759

[a] Figures compiled from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

PRODUCTION IN CANADA.[1]

Production of gypsum in Canada, 1914–1915.

Year.	Quantity (short tons).	Value.
1914	516,880	$1,156,207
1915	470,335	849,928

The gypsum sold in 1915 was classified as follows: Lump, 342,467 tons; crushed, 48,735 tons; fine ground, 6,455 tons; calcined, 72,678 tons.

In 1914 the quantities of the various grades were: Lump, 351,729 tons; crushed, 49,441 tons; fine ground, 6,097 tons; and calcined, 109,613 tons.

TRADE AND MANUFACTURING CONDITIONS.

The average price of both raw and calcined gypsum decreased 9 cents a ton in 1915. One new mill was in operation in 1915 in New York. There were 77 active gypsum mines, quarries, and pits in the United States and Alaska, which supplied 69 domestic plants. Of these 69 plants, 50 used gypsum, 10 used gypsite, 7 used both gypsum and gypsite, 1 reported the use of selenite crystals, and 1

[1] Preliminary report on the mineral production of Canada during the calendar year 1915, Canada Dept. Mines, Mines Branch.

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used gypsum sand. Thirty-two plants obtained their material quarries and open pits, 30 from mines, and 7 from mines and qua Seven plants sold ground gypsum only, 30 sold only calcined rial, and 32 sold both calcined and uncalcined gypsum.

Of the 62 calcining plants, 53 were equipped with kettles, 3 with rotary kilns, 5 with stationary kilns, and 1 with a baffle-plate furnace. There were 163 calcining kettles in operation.

The fuel used at 40 calcining plants was coal; oil was used at 18 plants, wood at 2 plants, and coke at 2 plants. The oil-burning plants are in Arizona, California, Kansas, Nevada, New Mexico, Oklahoma, Oregon, Texas, and Washington.

These summaries do not include the equipment of several plants termed "mixing mills," which are auxiliary mills established at commercial centers, such as Chicago, Ill., Milwaukee and Superior, Wis., St. Paul, Minn., and Cleveland, Ohio. These mills do no calcining, but receive the calcined plaster and prepare it for the market in various forms by the addition of fiber, retarder, and sand.

Six plants reported the manufacture of Keenes cement, and 12 plants reported making gypsum block, tile, or board.

Gypsum was calcined in 1915 at plants located in the following places:

Arizona: Douglas.
California: Amboy, Los Angeles.
Colorado: Loveland, Portland.
Iowa: Fort Dodge.
Kansas: Blue Rapids, Medicine Lodge.
Michigan: Alabaster, Grand Rapids, Grandville.
Montana: Great Falls.
Nevada: Arden, Moundhouse.
New Mexico: Acme, Alamogordo, Oriental.
New York: Akron, Garbutt, Oakfield, Wheatland.
Ohio: Castalia, Gypsum, Port Clinton.
Oklahoma: Acme, Eldorado, Okeene, Primm, Southard.
Oregon: Gypsum.
South Dakota: Black Hawk, Rapid City.
Texas: Acme, Plasterco.
Utah: Nephi, Sigurd.
Virginia: North Holston, Plasterco.
Washington: Tacoma (using Alaska gypsum).
Wyoming: Basin, Greybull, Laramie, Red Buttes.

Gypsum from Nova Scotia was calcined in 1915 at Brooklyn, New Brighton, Newburgh, and New York City in New York State, and at Chester in Pennsylvania.

KEENES CEMENT.

A hard-finish wall plaster manufactured at gypsum mills is known as "Keenes cement." It differs from ordinary gypsum wall plasters in method of manufacture, time of setting, and superior hardness. Pure gypsum is burned at a low temperature so as to convert it into the hydrate ($2CaCO_4.H_2O$); the lumps are soaked in a solution of alum, aluminum sulphate, or borax, and are then recalcined at about 500° C. (932° F.). On grinding, they give Keenes cement. According to another method the gypsum in small lumps is calcined in small vertical kilns similar to lime kilns and so constructed that only the gaseous products of combustion come into contact with the gypsum, in order to avoid contaminating it with the ash of the fuel. The gypsum is brought to a red heat, after which it is treated with a 10 per cent solution of alum and allowed to dry. It is again calcined, this time to a dull red heat, and then ground to flour. Keenes cement is made at some plants in the United States by a simpler method, concerning which there is some secrecy.

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METHOD OF PREPARING GYPSUM FOR USE.

Rock gypsum is mined or quarried, according to its relation to the surface and to the character and thickness of the overburden. Gypsum beds in most places lie nearly flat, and in underground work the room and pillar system of mining is followed, as in mining flat lying coal beds. Gypsite or gypsum earth always lies close to the surface, is soft, and is dug by hand or taken up by the use of plow and scraper. Rock gypsum is put through mills which crush it to pieces less than one-half an inch in size; then it passes through a drier, a large rotating cylindrical tube. The crushed rock is fed into one end of the drier and hot gases into the other end. In passing through, the superficial moisture is driven off from the gypsum, which is delivered at a temperature of approximately 100° F., ready for pulverizing. Various types of pulverizers are used, including burr mills, emery mills, disintegrators, and the pulverizing and air-separating system. These reduce the rock to powder of such a fineness that 80 per cent will pass a 100-mesh screen.

The pulverized gypsum is raised by elevators to storage bins at the top of the building and flows by gravity to the calciners, the common type being stationary kettles. A calcining kettle has a diameter of 8 to 14 feet and a depth of 6 to 10 feet, is set over a masonry fire box, and is surrounded by a shell of brick. Coal is burned under the kettle and the heat makes the gypsum fed into the kettle give off its water of crystallization in the form of steam. This steam, passing through the material, floats it up so that by the time the kettle is full the material resembles a boiling fluid. When the calciner is full the feeding process is stopped. Cooking is continued until the gypsum is calcined or the proper amount of moisture has been driven off. Then gates are opened at the bottom and the hot powder flows out, usually upon a conveyor, which moves the calcined gypsum to another part of the mill where it may be reground and screened before going to the mixing machines. In the warehouse a small quantity of retarder is added to the calcined gypsum to regulate the time of set, and other materials, such as hair, manila fiber, cut-wood fiber, and sand may be added to increase the strength or volume of the plaster. These materials are added in varying proportions to make the different kinds of plaster required by the trade. They are blended with the calcined gypsum in a mixing machine, which feeds into an automatic sacking machine.

The cost of a gypsum plaster mill varies with capacity and type of mill, availability and kind of building material, and conditions of labor and transportation. Estimates of approximate cost of plaster mills, wood construction, including necessary buildings, mills, kettles, conveyors, bins, complete are: Capacity, 25 tons in 24 hours, 60 horsepower steam plant, cost $7,000 to $9,000; capacity, 100 tons in 24 hours, 150 horsepower steam plant, cost $25,000 to $30,000.

A mill with steel construction and fireproof throughout will cost considerably more.

USES OF GYPSUM.

UNCALCINED.

Uses.—As shown in the foregoing tables, nearly half a million tons of gypsum is sold annually without calcining. The bulk of this

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material is used for retarder in Portland cement. Minor quantities are used as a pigment base for paints, in making cold water paints, crayons, as filler for paper and cloth, as base for insecticides, and as land plaster or fertilizer. The last use, which consumed nearly 70,000 tons in 1915, is one that has been practiced for many years but which would be increased very materially if the farmers would spread gypsum in their stables where it would do the most good. So little has been said in these annual reports on this particular subject that the following paragraphs are offered in explanation.

Gypsum on the farm.—One of the first uses made of gypsum in this country was as land plaster, and for many years it was the principal use. For this purpose the rock is ground to a fine powder but not calcined. Raw gypsum applied to some soils has a beneficial effect with some crops, especially clover, peanuts, alfalfa, and other legumes. The action of gypsum as a fertilizer is indirect and not as a plant food itself. It is supposed to act on the double silicate of magnesia and potash, setting them free to act as plant food. The necessary elements must first be present in the soil to obtain any beneficial effect. In other words, the application of gypsum to some soils would be ill-advised.

Land plaster, it is claimed, tends to make nonporous clay soils more pervious to water and to make sandy soils less pervious and is of benefit in sweetening sour and acid soils. Another characteristic of ground gypsum is that it has an affinity for water and will draw moisture from the atmosphere. This quality is a great factor in keeping moisture in the soil and is of value to the farmer in starting the growth of grain and grass, as it holds moisture where the roots of the small plants most need it. The application of ground gypsum or land plaster to the foliage of many plants in a dry hot season will draw the necessary moisture from the atmosphere to save a crop from being damaged by drought. It is commonly applied to peanut vines to insure a crop.

Perhaps the greatest advantage from the use of ground gypsum by the farmer is had by a liberal application of it on stable litter and manure to conserve ammonia. Ammonia is a chemical compound composed of 82 per cent nitrogen and 18 per cent hydrogen. Nitrogen is one of the most valuable plant foods and soil ingredients and is also one of the most difficult to conserve. One of the characteristics of nitrogen is that it is always trying to get away. Every farmer knows that the manure from the stables is rich in ammonia and that the ammonia ordinarily escapes from the manure before he can get it spread on the land. The valuable plant food, nitrogen, contained in the manure is therefore lost. The liberal use of ground gypsum around the stables and on the manure prevents the escape of the ammonia, chemically fixes the nitrogen, keeps the manure from heating and burning, kills the odor, and reduces the attraction for flies. It is therefore of great advantage to the farmer to make daily free use of land plaster in his stables. It should be applied to the litter and manure at the rate of from 5 to 10 pounds per animal per day. This daily use mixes the plaster thoroughly with the manure with which it will be applied to the soil and results in saving for plant food the nitrogen that would otherwise escape into the air.

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Land plaster may be applied to the soil by drilling or may be sowed broadcast. When applied in this manner it should be used at the rate of 200 to 500 pounds per acre.

CALCINED.

Calcined gypsum amounting to about a million and a half tons annually is used as wall plaster. This use and the qualities of the plaster, such as hardness, quick set, fire resistance, and poor conductivity of heat and cold, are so well known that further discussion will not be given here.

The making of gypsum board, tile, and screed is the newest branch of the industry and has not yet attained any considerable proportions; at least, the total value of the annual production of this material is probably less than $200,000. The statistical cards sent out by the Geological Survey do not ask specifically for reports on these products. Nevertheless, the reports for 1915 show that they were made at 12 plants in that year.

Gypsum plaster boards are of various types, mainly consisting of gypsum mixed with fibrous binding material to give strength and toughness for effective nailing. A type of plaster board in common use consists of four alternate layers of wool felt with three intermediate layers of gypsum. Other boards contain but two layers of felt with a gypsum layer between. In order to meet the joint and stud spacing of standard construction, plaster boards are usually 32 by 36 inches (8 square feet) and are made one-fourth, three-eighths, and one-half inch in thickness. The wool felt binding material forming the outside surface of the plaster boards is an excellent bonding surface for gypsum plaster. Plaster boards are used for lathing in place of wood or metal lath on surfaces that are to be plastered and where high fire-resistive construction is required. In fireproof construction the plaster boards are fastened to metal studs or hangers by metal clips. On surfaces not to be plastered plaster boards are used for deadening sound by being laid between rough and finished floors; as sheathing boards by being nailed to the studding and behind the clapboards; as outside sheathing, which is waterproofed before application of outside stucco covering; as insulation and fire resistance under wood shingles, in air ducts, and in dumb-waiter shafts.

Gypsum floor screeds are used as a nailing sleeper for floors. They are 2 by 3 inches and 8 feet long and weigh 2 pounds per linear foot. They do not rot or burn.

Gypsum tile is made for partitions, floors, roofs, and furring. Partition tile, solid or hollow, is 12 by 30 inches wide and 2 to 8 inches thick. These tiles, laid with gypsum plaster, are used in the highest type of fireproof building for dividing and corridor partitions, in elevator and stairway inclosures, and in dumb-waiter shafts; they are light in weight, can be laid very rapidly, can be cut with a handsaw, and, when plastered with gypsum, make partitions of high heat-resistive value.

Gypsum floor tile is a hollow box or dome of reinforced gypsum plaster, used as a filler between concrete joist construction. These tiles are 19 inches wide and 24 inches long, 7, 9, 11, and 13 inches high, and weigh 24, 27, 30, and 33 pounds per linear foot; they afford

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a saving in dead weight of construction and provide a smooth, all-gypsum ceiling to plaster upon.

Gypsum roof tile is made 24 and 30 inches long, 12 inches wide, and 3 inches thick, and is laid between supporting subpurlin "T" irons. Larger gypsum roof tile, reinforced and made of especially hard gypsum, are made to span 4 feet and are laid upon the main roof purlins. These tile are 4½ inches thick, 18 inches wide, and of biscuit pattern. All these roof tiles weigh 13 pounds per square foot and are light and noncondensing. The low heat conductivity of gypsum is an especially valuable quality in a roof deck. Slate or any other roof covering can be nailed or otherwise secured to the smooth decks of gysum roof tile.

Gypsum furring tile are of the same character and general dimensions as the partition tile, are hollow or solid, and are 2 inches thick. They are fastened to the wall by nailing and are used for sound absorption and soundproofiing, fire protection, insulation from heat or cold, and damp proofing.

Other uses for calcined gypsum which have been in practice longer than those just described, are in making statuary and other art work, relief maps and models, molds for rubber stamps, molds for pottery and terra cotta, in bedding plate glass for polishing, in foundry molds for special castings, and in making surgical casts. Calcined gypsum enters into the composition of match heads, hat blocks, relief decorations for walls and ceilings, asbestos pipe covering, and is used for various other purposes.

The Geological Survey has in preparation for publication a report on gypsum deposits in the United States and a paper on methods of preparing gypsum for use. Notice of these publications will be sent to the newspapers of the country when they are ready for distribution.

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BARYTES AND STRONTIUM.

By JAMES M. HILL.

INTRODUCTION.

With the report on barytes and strontium in 1915 the Geological Survey is endeavoring to extend its usefulness. Heretofore the annual reports on these minerals have dealt only with the output of the crude materials and have not attempted to present much information relative to the uses of crude barytes. It was known that the crude material found a considerable market, but not until the middle of 1914 was the demand for this material in the chemical industry appreciated. In August, 1914, began a series of inquiries from consumers of barytes for domestic supply which led to a voluminous correspondence, but the Survey had little information regarding the products made from crude barytes. Consequently, the desire to be of service not only to the producers but also to the users of barytes led the Survey to undertake a canvass of the new chemical industry. In this work it met the cordial cooperation of the whole industry, to the members of which its thanks are due for the confidential statements and reports so generously given.

The owners of strontium-bearing deposits in the United States have likewise made reports, and inquiries received by the Survey within the year indicate that though for several years there has been no domestic production, there is some foundation for the belief that the domestic strontium deposits may be worked.

For many years Missouri has supplied the greater part of the crude barytes mined in the United States, but Georgia and Tennessee have produced considerable quantities, and the deposits in Kentucky and Virginia have been more or less productive. Probably the most important reason for the small output from the western deposits is the fact that the market for crude barytes, principally among grinders and makers of lithopone and barium chemicals, is east of the Mississippi and that the largest market is east of the Alleghenies. The freight rates on a commodity of the low value of barytes necessarily determine the deposits that can be worked profitably.

From information received by the Survey it would appear that the barium industry is on a firm foundation, and should continue prosperous under the normal conditions of foreign competition, particularly in the chemical industry. The miners of crude barytes will also feel the return of normal conditions, for prior to 1915 European barytes could be sold to eastern manufacturers cheaper than domestic ore. This was owing largely to the high freight rates from central and southern territory to the markets, which there seems to be small chance of reducing.

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CRUDE BARYTES.

PRODUCTION.

The marketed production of crude barytes in the United States in 1915 was 108,547 short tons, valued at $381,032. This is a notable increase over the production in 1914, which was 52,747 short tons valued at $155,647. The increase was in large part due to the activity of the mines in Georgia, Kentucky, and Tennessee. The Missouri mines, as will be seen from the following table, made an increase of approximately 6,000 tons, but that is much below the increase in Geogia and Tennessee, which amounted to more than 15,000 tons in each State; The increase in Kentucky from a nominal quantity in 1914 to 7,753 tons in 1915 is remarkable. It is interesting to note that Alaska has entered the list of producers of barytes.

It may be well to indicate that the "marketed production" is the total quantity of barytes sold or used by companies which own their own mines. This figure may be greater or less than the actual quantity mined dependent on whether the stocks carried by the mines over a period of years are small or large.

Crude barytes marketed in the United States, 1913–1915.

State.	1913			1914			1915		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
Georgia	(a)	(a)		(a)	(a)		31,027	$102,825	$3.31
Kentucky				(a)	(a)		7,753	28,427	3.67
Missouri	31,131	$117,638	$3.78	33,317	$112,281	$3.37	39,113	158,597	4.05
Tennessee	2,098	3,568	1.70	10,113	16,273	1.61	25,074	71,390	2.85
Other States[b]	12,069	35,069	2.91	9,317	27,143	2.91	5,580	19,793	3.55
Total	45,298	156,275	3.45	52,747	155,647	2.95	108,547	381,032	3.51

[a] Included in "Other States."

[b] Includes, 1913: Georgia, North Carolina, South Carolina, and Virginia; 1914: Alabama, California, Georgia, Kentucky, North Carolina, South Carolina, and Virginia; 1915: Alabama, Alaska, California, North Carolina, South Carolina, and Virginia.

PRICES.

The prices paid for crude barytes in 1915 varied considerably in different States; thus, in Georgia the average price was $3.31 a short ton; in Missouri the price was $4.05 a short ton f. o. b. cars. These prices are higher than in 1914, but the average price did not advance as much as might have been expected, one factor in keeping it down appearing to be the opening of many deposits which have been idle for some time and whose output increased the supply in 1915. It is reported, however, that the demand for crude barytes by the manufacturers of lithopone, ground barytes, and barium chemicals has been very brisk. These augmented uses for domestic material have had a marked influence on prices, and it is understood that there has been a further increase in the price of crude barytes in 1916

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STOCKS.

The apparent stocks of crude barytes held at mines at the end of December, 1915, were 9,676 short tons, 6,500 of which are held in Tennessee, 2,500 tons in Georgia, and the remainder in small quantities in the other producing States. The apparent stocks in 1914 as shown by revised figures, were 11,743 short tons, a large part of which was held in Tennessee.

The term stocks as used by the Survey includes only those stocks held at mine or shipping point, which have not entered the market. It is known that there are considerable stocks of crude barytes held by the lithopone and chemical companies and by grinders, but as these have been purchased or mined and shipped by these companies they are considered as a marketed product in the sense used by the Survey.

IMPORTS.

According to figures compiled from the reports of the Bureau of Foreign and Domestic Commerce, Department of Commerce, 2,504 short tons of unmanufactured barytes were imported in 1915, which from the price given is believed to be crude barytes, though the tariff schedules are not entirely clear on this point. As will be seen from the following table, this is a reduction of approximately 22,000 tons from the imports in 1914, a reduction accounted for by the loss of imports from Germany:

Barytes imported for consumption, 1911–1915.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1911	20,214	$36,643	1914	24,423	$46,782
1912	26,186	52,467	1915	2,504	4,877
1913	35,840	61,409			

CONSUMPTION.

The apparent consumption of crude barytes in 1915 was 111,051 short tons, the sum of the marketed production and imports, which exceeded the apparent consumption of 1914 by 33,881 short tons. Reports received by the Survey indicate that of the marketed production of domestic barytes approximately 50 per cent was used by grinders, 40 per cent by manufacturers of lithopone, and 10 per cent by makers of barium chemicals.

CHARACTER OF BARYTES.

Barytes, the mineral barite (barium sulphate) sometimes called "heavy spar" or "tiff," theoretically is composed of 65.7 per cent of barium oxide (BaO) and 34.3 per cent of sulphur trioxide (SO_3) and has the chemical formula $BaSO_4$. The specific gravity of the mineral ranges from 4.3 to 4.6 and its hardness varies from 2.5 to 3.5. It is commonly found as an aggregate of straight or slightly curved cleavable plates, but it occurs also in granular, fibrous, and earthy masses, and in the form of stalactites. It can be distinguished from calcite

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by its greater weight and by the acid test. Calcite will effervesce with acid but barite will not react.

Most of the crude barytes mined in the United States has some iron in the form of oxides as a coating on joints, faces of crystals, and surface of the lumps. Iron lead, and sinc sulphides, and occasionally copper sulphide are found in the barytes from some localities. Silica, in the form of both quartz and chert, and calcite and flourite are objectionable impurities which are present in some deposits. Commercial crude barytes should carry more than 93 per cent barium sulphate and the better grades of domestic barytes carry at least 95 per cent $BaSO_4$.

In the trade two types of barytes are recognized, "hard crystalline" and "soft." The hard crystalline variety ordinarily has a glassy semitransparent look and can not be broken in the hands. The soft variety, as the name implies, can usually be crumbled, at least the edges of the crystals, by the fingers. The soft variety has a dull milky white color on fresh fractures, is preferred by grinders, and is said to roast better than the hard variety. The hard variety, however, can be made to roast well by a preliminary heating and therefore can be used to better advantage in the lithopone and chemical industries than by the grinders.

All the commercial barytes is graded according to the impurities, particular attention being paid to the content of iron and silica.

MINING AND PREPARATION FOR MARKET.

Until the last few years the mining and preparation of barytes for market has not been conducted in an efficient manner. Most of the productive deposits are of the residual type. The mining is a relatively simple matter and has been done by hand either in open cuts or through shallow shafts. The open cut method would appear to be the most economical and could be used in practically all of the residual deposits with which the writer is acquainted. The ground is broken by picks, the material is shoveled into wheelbarrows or in some places into dump carts, and is hauled out for further treatment.

It has been proposed to mine some deposits by the use of steam shovels, which would undoubtedly handle the barytes-bearing clay in an economical manner; yet there is a factor of considerable importance which should be considered by those contemplating an installation of that character, namely, the spotty nature of most of the deposits. Even in the best deposits there are considerable masses of clay that do not contain barytes. In mining by hand these masses can be left; but the steam shovel would require their removal; and it is therefore doubtful whether this cheap method can be used in a large majority of the mines.

The hydraulic giant would handle these residual clays and could be used to advantage in connection with transportation flumes, log washers, and jigs, all of which would assist in the disintegration and removal of the clay. Unfortunately in the regions where the residual deposits are found the cost of obtaining water under sufficient head to conduct hydraulic mining is prohibitive in view of the low price of the mineral won. In Washington County, Mo., an installation using large steam pumps to obtain head demonstrated the possibility of handling residual barytes deposits by giants, but did not prove commercially successful.

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Where power is cheap or water under sufficient head is available hydraulic mining might well be more thoroughly tested than has yet been done.

Under the system of mining by hand the clay is roughly separated from the barytes in the mines and wheeled to the dump, and the barytes, coated with more or less clay, is thrown out on drying floors where the action of rain and sun disintegrate the clay to some extent.

In some places in Missouri the dried tiff (barytes) is further cleaned in shaking boxes, built somewhat after the manner of a cradle. The barytes is finally hand cobbed to remove chert, clay, galena, sphalerite, and other impurities and is graded according to the cleanness of the resulting material. In this handling, large quantities of finely broken barytes are lost, and can not be recovered by any hand methods.

For some time it has been realized that log washing and jigging would increase the production and yield a cleaner and more valuable product than could be produced by drying and hand cobbing. In 1914 a few washing plants were installed at mines, and in 1915 and 1916 there have been a number of equipments of this sort, particularly in the Eastern States. The water problem again enters with the installation of log washers, but is not usually serious.

At the plants visited by the writer the washers of either the 1 or the 2 log tandem type, are placed near the open cuts where the barytes-bearing clay can after a short haul be dumped through railroad iron grizzleys into the washers. Everything taken from the cut, except the clay that is evidently barren, goes into the washer. From the washer in the better equipped plants the washed barytes goes over a ½-inch mesh trammel, the oversize from which, after hand picking of the chert, goes to the barytes shipping bin. The undersize is fed to 2, 3, or 4 compartment jigs ordinarily of the Hartz type. A clean barytes concentrate is produced, and the tailings show very little loss of barite. It would seem from the success attained in the Georgia and Tennessee fields by the use of log washers and jigs that there need be no further discussion of the desirability of the installation under suitable conditions. In the Missouri field, where the conditions are not the same as in the East in that many independent miners may be working on a single deposit, it would seem that custom plants, perhaps operated by the landowner, might prove to be the solution of the problem.

PRODUCERS.

In the last two years the Survey has had so many inquiries from both producers and consumers of barytes concerning possible markets and sources of supply that it seems advisable to indicate in a general way the present conditions of handling barytes.

In Missouri most of the barytes passes through two and sometimes three hands before it reaches the consumer. The miner sells to a local buyer, most often a storekeeper, in exchange for goods. This buyer sells to a larger buyer having access to the railroad, who in turn sells to one of the larger selling companies or to the consumer. It is next to impossible to deal with the miners or even the first buyers. Often the second buyers are agents for some of the larger purchasing companies and do not deal directly with the consumer. In the

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pany will have four furnace houses in Niagara Falls, N. Y., and one in Niagara Falls, Canada, accommodating in all about 40 furnaces.

The demand for graphite electrodes greatly increased during the year on account of the remarkable growth in certain electrochemical industries. The extent of this growth is indicated by the statement [1] that during 1915 the number of electric steel furnaces in operation in this country increased 78 per cent. It is interesting to note that the graphite electrodes made at Niagara Falls range in size from a diameter of one-sixteenth of an inch to a diameter of 12 inches and a length of 77 inches.

The bulk graphite produced by this company in 1915 was reported as 2,542 short tons, valued at $99,633. This represents only the graphite which would come into competition with natural graphite and does not include certain graphitized products that do not compete with natural graphite. This material, most of which is made either from anthracite or from petroleum coke, comes from the furnace in an earthy, incoherent condition, and is utilized mainly in lubricants and paints, and for foundry facings, boiler-scale preventives, and battery fillers.

MARKETS AND PRICES.

The prices paid to importers in New York for Ceylon graphite during 1915 were approximately as follows:

Prices of Ceylon graphite at New York, 1915.

	Cents per pound.		Cents per pound.
Ordinary lump:		Dust:	
Best	9 –22	Best	5 –7½
Medium	7½–15	Medium	4 –6
Poor	6 –12	Poor	3 –6
Chip:		Flying dust:	
Best	7 –15	Best	3 –5
Medium	6 –13	Medium	2½–4
Poor	5 –10	Poor	2 –3

In general the smaller figures represent the prices at the beginning and the larger figures the prices at the end of the year. The increase in price during the year was fairly regular and has continued from the end of 1915 to the date of writing (March, 1916), the best grades of Ceylon lump now selling at 22 to 23 cents per pound. Only small quantities of the poorer grades of Ceylon graphite were imported during 1915, the extraordinary demand for the higher grades and the shortage of bottoms crowding out the cheaper grades. The present high prices are a result of increased demand, increased freight rates, war surcharges, and higher rates of insurance. At the end of 1915 the freight rates from Ceylon were approximately three times what they were before the outbreak of the European war, and early in March, 1916, they had increased to about five and one-half times the antebellum rate. A part of the increase in 1916 is due to the fact that all Ceylon graphite now comes around the Cape of Good Hope instead of by the Suez Canal, to avoid danger of capture or destruction in the Mediterranean.

The graphite-mining industry in Ceylon was in a very depressed condition during 1914 because of shortage of labor and of the unu-

[1] Iron Age, Jan. 6, 1916, p. 95.

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sually heavy rains, which interfered with mining operations. This depression was aggravated by the embargo imposed in October, 1914, on the exportation of graphite to countries other than those of the allies. After the modification of the restrictions on exports to the United States about the middle of 1915 and because of the greatly increased demand for graphite for crucibles to be used in the manufacture of munitions, most of the mines resumed operation.

The exports of graphite from Ceylon to the United States in 1915 considerably exceeded those in 1914, and the loss of the German and Belgian trade was partly compensated by increased exports to the United Kingdom and by large exports to Russia, which hitherto had consumed almost no Ceylon graphite.

The figures for 1913 and 1914 below are taken from the Ceylon Blue Book, and those for 1915 from the report of the Ceylon Chamber of Commerce.

Exports of graphite from Ceylon, 1913–1915, in short tons.

Country.	1913	1914	1915	Country.	1913	1914	1915
United States	14,461	6,928	13,821	Italy	21	5	.....
Germany	6,178	3,148	.....	Holland	8	24	.....
United Kingdom	5,348	2,636	5,389	Japan	107	62	16
Belgium	1,969	865	.....	Russia in Europe	.....	4	1,998
British India	27	58	52	Other countries	74	21	18
Victoria	225	318	244				
Austria	.....	35	.....		28,540	14,228	21,538
France	122	124	.....				

Importers of Ceylon graphite and those who purchase it from the importers are required to furnish to the local representatives of the British Government a guaranty, drawn up in prescribed form, in which they agree not to sell "plumbago crucibles or plumbago in a form suitable (whether after refining or otherwise) for the manufacture of or for use as crucibles, foundry facings, or lubricants" to countries at war with Great Britain or to neutral countries, except "by shipments to the United Kingdom or France and reshipment from there, under license to be obtained for export therefrom."

The purpose of the guaranty is to prevent a mineral mined in a British colony and valuable in the manufacture of munitions of war from reaching the enemies of Great Britain. As, however, Ceylon graphite is not specifically mentioned, the guaranty virtually prohibits the exportation of graphite or graphite products, whatsoever the source of the graphite, to neutral countries by firms who handle even small quantities of Ceylon graphite. As several large American dealers handle graphite from many sources, this required guaranty has affected their established trade with neutral countries. This result is perhaps unavoidable in view of the difficulty in determining whether the graphite in a manufactured product came from Ceylon or from some other source. However, most American manufacturers of graphite products have been taxed to their full capacity to meet the demands of the domestic trade and of the allies, hence the effect of the restriction has not been as serious as might be supposed.

Many crucible makers are far behind in filling their orders because of the difficulty in obtaining sufficient graphite of crucible grade.

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Their difficulties have been further increased by the cutting off of the supply of clay from Klingenburg, Bavaria, which was used as a binder in graphite crucibles and was used, also, in pencil manufacture. None of this clay was imported in 1915, and the accumulated reserves are now practically exhausted. American crucible makers have conducted extensive tests to determine the suitability of certain American clays as substitutes, and many of them have husbanded their supplies of Klingenburg clay by mixing domestic clay with it. On the whole, the results obtained with the American clays have been fairly satisfactory, and it is to be hoped that when manufacturers have become familiar with the mixing and blending of the domestic clays a product will result that will be fully as satisfactory as that obtained from the Klingenburg clay. The most essential properties of a clay for use as crucibles are that it must be plastic, must not soften materially at 2,600 or 2,700° F., and must not spit or blow at high temperatures.

Madagascar graphite was imported in 1915 in considerably larger quantity than in 1914. The French Government has required guaranties essentially identical with those required by England for Ceylon graphite. The price c. i. f. New York increased from about 6 cents per pound at the beginning of the year to 11 or 12 cents at the end of the year. There was no notable change in the character of the graphite as compared with 1914; it averaged about 85 per cent graphitic carbon, was not subdivided into grades, and required finishing in this country before utilization. Most of it was consumed in the manufacture of crucibles. The scarcity of bottoms and the increasing demand in France for the Madagascar product makes it impossible at present for American firms to obtain as much of this graphite as they desire.

The price of Chosen (Korean) graphite early in 1915 was about $25 per ton c. i. f. New York. As a result of increased marine freight rates and the scarcity of bottoms, the price in New York rose to about $40 per ton at the end of the year and to $50 in March, 1916. Some of the material has come by rail from Seattle to the Atlantic seaboard. The Japanese Government has required no guaranties from consumers in regard to the utilization of this graphite. Graphite from Chosen is amorphous, analyzes 80 to 85 per cent graphitic carbon, and is used mainly for stove polishes, foundry facings, paint pigment, and the prevention of boiler scale.

The unsettled conditions in Mexico resulted in greatly reduced imports of Mexican graphite in 1915 as compared with 1914. The better grades of this graphite suitable for pencil manufacture normally bring 4 to 5 cents per pound c. i. f. New York. Late in 1915 the price rose to 5 to 6 cents per pound.

The better grades of American flake graphite sold in large lots at the mines in the eastern United States at from 6 to 8 cents per pound and in New York City at from 8 to 10 cents per pound. Small lots sold as high as 14 to 18 cents per pound in New York. Market conditions were reported by most producers to be very good.

Almost the entire Canadian production of graphite was imported into the United States, where it sold for about the same prices as the similar American flake graphite. The imports were much larger in 1915 than in 1914.

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REVIEW BY STATES AND TERRITORIES.

ALABAMA.

Four firms produced graphite in Alabama in 1915, the Alabama Graphite Co., the Quenelda Graphite Co., and the Jennings Graphite Co., all near Ashland, in Clay County, and the Flaketown Graphite Co., near Mountain Creek, in Chilton County. The Jennings Graphite Co. began operation late in 1914 and reported an important production in 1915. Its mine is 4 miles west of Lineville; its mill is equipped with an electrostatic separator.

Three new companies have recently begun operations near Ashland, but marketed no graphite during 1915. The Clay County Graphite Co. (Inc.) has a mine and a mill 2 miles north of Ashland. The mill began operation in March, 1916. The Standard Graphite Co., whose office is at Ashland, is developing a graphite property 8 miles west of that place. A mill is in process of erection and the property is expected to begin producing about the middle of 1916. The third company is known as the Southern Graphite Co.; its mine is about 3 miles northwest of Ashland and its mill is now (March, 1916) under construction.

ALASKA.

Some assessment and development work was done at the mine of the Alaska Graphite Co., near Teller, in the Port Clarence mining district, but no graphite was marketed during the year.

CALIFORNIA.

Several graphite properties in California were visited by the writer in March and April, 1915, and are briefly described below.

The graphite deposits of Los Angeles and San Diego counties resemble the characteristic deposits of New York, Pennsylvania, and Alabama in that the graphite occurs as crystalline "flakes" disseminated through a schist. The flakes in the California graphite schists are, however, much smaller than those in the eastern deposits, most of them not exceeding 0.25 millimeter in diameter. For this reason the problem of their concentration is somewhat different from that of the eastern deposits; furthermore, the concentrate would not be adapted for use in the manufacture of crucibles or other refractory products, for which a coarse flake is essential. On the other hand, the percentage of graphite in the California deposits appears to be nearly twice that of most of the eastern deposits of flake graphite. Another advantageous feature is the scarcity of mica, a mineral particularly difficult because of its flaky character to separate from flake graphite.

The California properties present, therefore, a number of favorable features. The fineness of the graphite undoubtedly renders difficult its complete separation from the gangue minerals, but there should be no great difficulty in obtaining a concentrate sufficiently rich in graphite to serve for foundry facings, boiler-scale preventive, and paint pigment, and at the same time in conducting experiments with a view to securing a purer product. For the uses mentioned above the graphite would have to compete with Chosen amorphous graphite, which before the outbreak of the European war could be bought at

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from $22.50 to $25 a ton in New York and at a still lower price on the Pacific coast.

SAN BERNARDINO COUNTY.

Several small graphite prospects occur in Eva Canyon, just north of Ontario and Upland. These are from half a mile to a mile from the mouth of the canyon in an area of crystalline schists and associated granite pegmatite. At the graphite prospects the schists are much decomposed, and in places there has been much slipping parallel or nearly parallel to their foliation. The greatest width of highly graphitic material noted was about 5 feet. The graphite is crystalline but very fine grained, and is so intimately mixed with silicates that it could probably not be separated from them economically in deposits so small. As the graphite layers are narrow and steeply inclined they would have to be mined by tunneling and stoping. The graphite and associated silicates, if ground without attempt at concentration, might command a local market for foundry facings, boiler compound, and paint pigment.

LOS ANGELES COUNTY.

A graphite property has been developed by the California Graphite Co., of Los Angeles, about 20 miles northeast of Saugus, near the junction of Bear and San Francisquito canyons. Saugus, on the Southern Pacific line, is the nearest railroad point, and the entire haul is downhill. The property was discoverd by G. A. Skinner in 1906; considerable development work has since been done and some experiments in concentration have been made. The workings are on steep mountain sides about 500 feet above the neighboring streams, which would furnish abundant water for wet concentration.

The graphite occurs disseminated in very small flakes through a schist which is so much decomposed near the surface that it can be excavated without blasting and is easily crushed preparatory to concentration; at greater depths more firmness in the schist and greater difficulty in crushing are to be expected.

Microscopic study of samples from Prince No. 1 and Prince No. 4 claims show that nearly all the graphite is in flakes 0.25 millimeter or less in diameter, but at the head of the wire tram of Prince No. 1 claim schist carrying graphite flakes as much as 1 millimeter in diameter was noted. The principal mineral of the graphite schist is the aluminum silicate, sillimanite (specific gravity, 3.24); other minerals in approximate order of abundance are quartz, feldspar, and very small quantities of pyrite. Determinations were made in the Survey laboratory of the percentage of graphite in three samples collected by the writer from this property, with the following results:

Graphite in graphite schist from Los Angeles County, Cal., 1915.

	Percentage of graphite.
Composite sample of graphitic schist from many different localities on Prince No. 1 claim	7.29
Composite sample taken at intervals of about 1 foot across 50 feet of graphitic schist exposed in crosscuts in tunnel on Prince No. 4 claim	12.00
Sample of richest type of graphite schist from same tunnel	17.48

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The development work on Prince No. 1 claim includes a shaft 64 feet deep and a tunnel 108 feet long, all in the graphitic schist. The graphitic schist outcropping on this claim forms a band from 8 to 20 feet in width that has been traced for more than a quarter of a mile along the north side of San Francisquito Valley. The graphitic schist is locally much sheared and in places faulted into contact with altered granite.

The next most extensive development has been on Prince No. 4 claim, nearly half a mile east of Prince No. 1 claim. Here there is a tunnel about 200 feet in length parallel to the schist foliation, which strikes northeast and is nearly vertical. Crosscuts aggregating 100 feet in length expose fully 70 feet of schist, measured at right angles to the foliation, of which at least 50 feet is highly graphitic. A biotite granite, somewhat banded or gneissic in texture, is associated with the graphitic schist. Large samples from Prince No. 4 claim sent to Germany for experimental treatment are said to have concentrated 6 into 1, yielding a concentrate of lubricating grade.

SAN DIEGO COUNTY.

The Leebrick graphite mine is situated in the Mason Valley about 3 miles east of the head of Oriflamme Creek, sec. 10, T. 14 S., R. 5 E. The altitude of the mine is between 2,600 and 2,700 feet. It is about 80 miles distant by road from San Diego and about 50 miles from Foster, the terminus of the San Diego & Southeastern Railway. The workings consist of a short tunnel and several small open pits. Only development work has been done.

The deposit is a band of graphitic schist with a maximum width of 80 feet, which is traceable for about 400 feet. At the south end of its exposure this schist strikes about N. 85° W., but farther northwest the strike shifts to N. 60° W. The average dip is about 65° NE. The graphitic schist terminates on the southeast just below the main tunnel at a small gulch, which probably follows a fault. Beyond this, in line with the strike of the graphitic schist, only granite gneiss and pegmatite occur.

The percentage by weight of graphite in a composite sample of graphitic schist collected by the writer from a large number of places in this graphite deposit was determined in the Survey laboratory as 11.9 per cent. Microscopic study of the sample showed that most of the graphite flakes were less than 0.2 millimeter in diameter, and practically all were less than 0.5 millimeter. The associated minerals are quartz, brown hornblende, and a little pyrite.

The Seyer graphite property lies about 2 miles north of the Leebrick mine and has been opened by W. B. Seyer, of Julian, Cal. The property was not visited by the writer, but according to Mr. Seyer there are two graphitic bands 4 and 12 feet wide, respectively. Most of the graphite forms minute flakes a small fraction of a millimeter across in a fine-grained schist, but scattered through this schist are rounded nodules of graphite as large as a pea. The nodules are nearly pure graphite in flakes measuring as much as 0.5 millimeter in diameter; their origin was not determined. An analysis by the Survey of a sample of graphitic schist from this property furnished by Mr. Seyer showed 16.2 per cent graphite.

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COLORADO.

The mine of the Federal Graphite Co., near Turret, in Chaffee County, was idle in 1914 and 1915.

In 1914 Mr. Dexter T. Sapp, of Gunnison, Colo., reported the discovery of a vein of graphite in Gunnison County. The property is undeveloped. A small sample sent to the Survey was a hard amorphous graphite.

MICHIGAN.

The mine of the Detroit Graphite Co., near L'Anse, in Baraga County, Mich., has not been operated since 1913, enough graphite having been mined to fill the company's requirements to the present time. The company plans to resume mining during the summer of 1916 and to take out sufficient material to supply its needs for several years.

The plant of the Northern Graphite Works, also near L'Anse, was not, so far as could be learned, in operation in 1915

MONTANA.

Graphite mining was continued during 1915 at the mine of the Crystal Graphite Co., near Dillon, Mont., and important shipments were made to eastern markets. The appearance of the deposit as development has progressed is reported to be encouraging.

NEVADA.

The property of the Black Lead Mining Co., of Carson, Nev., was visited by the writer in the fall of 1915. It is about 4 miles by road southwest of Carson City, the haul from the mine to town being downhill all the way over a fair road. The claims are in secs. 25 and 26, T. 15 N., R. 19 E. Mount Diablo meridian; they have been developed mainly by W. H. Chedic, of Carson City. Small amounts of graphitic rock have been mined here for a number of years, most of it from an open pit near the line between secs. 25 and 26. The material exposed in this pit is a black graphitic shale which is considerably distorted but appears to have a general trend west and is traceable for several hundred feet west of the pit. This shale has been intruded, both south and north of the open pit, by a nearly black rock of basaltic appearance; the dike just south of the pit is at least 50 feet wide. The basaltic rock has in turn been intruded by several small dikes of pegmatitic granite and considerable masses of granite were noted a short distance east of the mine near the road to Carson. The proximity of the basaltic rock to the graphitic shale suggests that it was through the heat attending its intrusion in a molten condition into the black shale that a part, at least, of the carbon in the shale was converted into the graphitic state. The neighboring masses of granite may, however, have been in part responsible for the change. In sec. 26, a quarter of a mile or so northwest of the open pit referred to above, graphitic shale has been developed in a tunnel 172 feet long trending S. 8° E. The small open pit at the mouth of the tunnel and the northern part of the tunnel itself expose a width of about 100 feet of graphitic rock entirely similar to that at the open pit just described. The remainder of the tunnel is in the basalt. Both basalt and

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graphitic shale are cut by small dikes of pegmatitic granite. The intrusion of the granitic rock was subsequent to the development of jointing in the basalt, for in places the dikes follow joints. The graphitic shale has been traced in the surface for about a quarter of a mile west and for the same distance east of this tunnel.

A composite sample of the graphitic shale from 20 different places across the face of the larger open pit was analyzed in the Survey laboratory and was found to contain 49 per cent of carbon.

The graphite particles in this material are extremely fine, so that it is to be classed commercially as amorphous graphite. Separation of the graphite from its associated minerals is not economically feasible; but the material after fine grinding is suitable for use as paint pigment and as foundry facing, and most of that mined to date has been utilized in the manufacture of graphite paints in a small mill at Carson City, operated periodically by this company.

Small amounts of graphitic shale have also been found in sec. 25 on claims of Wm. W. Coleman, of Carson City.

NEW YORK.

The mine of the Joseph Dixon Crucible Co., at Graphite, in Warren County, N. Y., was operated continuously in 1915. The only new development was the resumption of mining at one of the old workings, the so-called Summer pit, which has not been worked in recent years. At the plant of this company at Jersey City, N. J., two new crucible kilns are being erected, which will increase the capacity of the crucible factory about 25 per cent. The pencil factory has recently been enlarged and a large annex has also been erected, which will permit of further expansion but which for the present will be used only for storage and shipping. Development work was continued by William Faxon on his property adjoining the Dixon mine, but no graphite was marketed.

The Graphite Products Corporation, with mines in the towns of Wilton and Greenfield, in Saratoga County, increased its production materially during 1915 and reports the erection of a new mill, which will about double its capacity.

The Popes Mills Graphite Co., with plant at Popes Mills, in St. Lawrence County, reported a small production in 1915.

J. J. Steacy, of Redwood, N. Y., under date of January 7, 1916, reported the discovery of a deposit of flake graphite in the town of Alexandria, in the northern part of Jefferson County. The deposit lies about 3 miles from Redwood, on the farm of John Stine, and borders Butterfield Lake. A sample forwarded to the Survey is a crystalline limestone carrying flakes of crystalline graphite, most of them between 1 and 2 millimeters in diameter. These flakes probably constitute about 5 per cent by weight of the rock. The material is similar in a general way to that formerly worked by the Crown Point Graphite Co., in Essex County, N. Y.

NORTH CAROLINA.

A few tons of graphitic rock were mined in 1915 by the Southern Graphite Co., at Barretts Mountain, near Taylorsville, in Alexander County, but no material from this property has been marketed.

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The principal graphite deposits of the State have been briefly described by the North Carolina Geological Survey,[1] and copies of the report may be obtained by addressing the State geologist at Chapel Hill, N. C. According to this report the graphite at Barretts Mountain occurs as a constituent of dikes of coarse granite (pegmatite), which vary from a few inches to 5 feet in width. In these dikes the graphite forms nodules from a fraction of an inch to 6 or more inches in width. The quantity of graphite in the dikes will not average over 25 per cent, but is said to be in places as high as 50 or 60 per cent. The nodules are nearly pure graphite.

PENNSYLVANIA.

Two firms engaged in mining graphite in Chester County, Pa., during 1915; these were the Rock Graphite Mining & Manufacturing Co., with mine and mill near Chester Springs, and the Graphite Products Co. (John H. Lilly in charge), which operated the property near Byers formerly worked by the Pennsylvania Graphite Co. The Chester Graphite Co., near Chester Springs, was engaged in refining graphite from various sources, but conducted no mining operation.

The property owned by Pettinos Bros., near Byers, was leased in April, 1915, to the Tonkin Graphite Co. The mill in process of erection by this company is not yet completed and no production was reported for 1915.

RHODE ISLAND.

Amorphous graphite was mined at Fenner's ledge on the outskirts of Providence, R. I., and sold for foundry facings. Six analyses of this material show a graphite content ranging from 25 to 64 per cent. In a report published in 1915 Ashley [2] shows that the graphite has been formed through the alteration of beds of impure coal. He says:

> Though all the anthracite contains more or less graphite, portions of the beds have been changed entirely to what appears to be graphite. Such a bed at Fenner's ledge is being mined at present in an open cut by Mr. Fenner and sold for foundry facings, for which it appears to be well adapted after the proper preparation. At the old Gross mine, to the south, an attempt was made to prepare the graphite for market. Buildings were erected and machinery installed. The graphite was crushed and screened, using expensive brass sieves. The process adopted did not prove successful, apparently owing to the difficulty of separating the fine quartz.
>
> Graphite has also been mined at Bridgeton, Valley Falls, and Tiverton, at the first and last places from open cuts, but at Valley Falls the workings were extended underground. The material was used for foundry facings and some of it for furnace linings.

VIRGINIA.

Development work was done in 1915 under the direction of C. H. Hurkamp, of Fredericksburg, at the Naylor graphite property, in the northern part of Albemarle County, Va. A new shaft has been sunk and encouraging showings of graphite are reported.

Prospecting for graphite has been carried on 3½ miles from Front Royal, in Warren County, on the property of J. H. Thompson, of Front Royal. A sample submitted to the writer is a schist in which graphite occurs in flakes, most of them under 1 millimeter (four one-

[1] Pratt, J. H., The mining industry in North Carolina during 1901: North Carolina Geol. Survey Econ. Paper 6, pp. 69–72, 1902.
[2] Ashley, G. H., Rhode Island coal: U. S. Geol. Survey Bull. 615, 1915.

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hundredths of an inch) in diameter. Associated minerals are mostly quartz, feldspar, and a little brown mica. A clean concentrate obtained from this material would be too fine grained for use in the manufacture of crucibles and other refractory products, but would be suitable for most other uses of graphite.

WASHINGTON.

Some development work has been done recently on graphite properties on the east slope of the Cascade Range in Chelan County, Wash. These deposits are several miles west of Nason station, on the Great Northern Railway near the confluence of Nason and Whitepine creeks. From the descriptions received there seem to be in this locality several bodies of schists carrying a small percentage of graphite, and in the schists occur "veins" or lenses, from a fraction of an inch to 18 inches wide, of material carrying a much larger percentage of graphite.

From the samples submitted most of the graphite, both of the "veins" and of the larger bodies, appears to be very finely crystalline, most of the flakes being considerably less than 0.5 millimeter in diameter. The separation of graphite of this fineness from its gangue minerals would involve serious though perhaps not insuperable mechanical difficulties, but simple pulverizing of the richer material would yield a product well adapted for use as paint pigment, foundry facings, boiler scale preventives, and possibly as stove polish. John Maloney, of Skykomish, is interested in the development of this property.

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POTASH SALTS.

By W. C. PHALEN.

DOMESTIC CONDITIONS.

The year 1915 was an epoch making one in the domestic potash industry There was produced in this country that year soluble potash salts valued at $342,000. Quantities are not given for the reason that the product sold came from diverse sources and contained varying proportions of potash. Though this figure for value is of interest as a small beginning in the domestic potash-salts industry, it is practically of no importance in comparison with the total needs of the country, as the quantity it represents is consumed in less than a week in normal times.

The price of potash salts has increased greatly since the domestic scarcity began to be felt. From a normal price of $35 to $40 a ton for high-grade agricultural salts, prices have advanced until in the spring of 1916 chloride and sulphate were quoted at ten times those figures or more. In April, 1916, chloride was nominally quoted at quoted at $425 a ton and sulphate from $350 to $400 a ton.

Experimental work on the production of potash salts from different sources was most active during 1915, and in some places experiment has passed into active construction of works for the production of soluble potash salts. By-product potash from cement manufacture has become a reality at Riverside, Cal. Potassium sulphate from alunite was first placed on the market late in October, 1915, at Marysvale, Utah. An important production of potash salts is announced from Jesse Lake, near Hoffland, western Nebraska. Some potash was marketed in the form of dried kelp, which, however, must be considered of organic, rather than mineral origin. Without much doubt, potash salts were produced in small quantity from feldspar or other silicate rocks and incorporated into mixed fertilizers without intermediate refinement. The value of this material can not be stated, nor is it included in the figure given, and the quantity is thought to have been small. The fertilizer manufacturers in general are not optimistic with reference to the silicates as a source of potash salts because only low-grade material can be produced and, further, because any plant established for this production would most likely have to be scrapped at the close of the present war in Europe.

Active operations are in progress in California at Searles Lake and at Keeler, on the shore of Owens Lake, and the by-product bittern at the solar evaporation plants on San Francisco Bay has also received some attention.

In Utah, near Great Salt Lake, as is reported, one company is erecting a plant and another plant will soon be begun at the south

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end of the lake. An additional plant is also planned for Marysvale for work on alunite.

Manufacturers of Portland cement having had their attention directed to a possible revenue from by-product potash, will not be slow to investigate their raw material thoroughly. Already the Security Cement & Lime Co., near Hagerstown, Md., is reported to be installing a plant for recovering potash salts.

Great activity has been manifested in experiments on other raw materials, such as feldspar, leucite, sericite, and greensand, but the great expense involved in obtaining potash salts from these sources, the uncertainties with which manufacturers will be confronted, and the keen German competition which must be met at the close of the European war are potent factors in discouraging any considerable undertakings.

IMPORTS.[a]

POTASH SALTS.

The imports of refined potash salts (all from Germany), which include the 80 per cent chloride used in agriculture, were about one-fourth in 1915 what they were in 1913, the last normal year, and the imports of kainite and manure salts were about 3 per cent of those in 1913. All the imports of potash salts taken together amounted in 1915 to about one-tenth of recent imports under normal conditions. The imports of fertilizers given also in the chapter on phosphate rock are shown here for comparison.

Potash salts imported for consumption into the United States, 1912–1915.

	1912		1913	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Potash:				
Carbonate of, crude	7,625,382	$224,868	9,715,878	$272,973
Caustic, not including refined	9,690,494	370,506	[b] 8,648,753	342,056
Cyanide of	726,659	109,434	1,470,987	216,844
Chloride of	482,529,396	7,229,121	475,261,595	7,075,745
Nitrate of, saltpeter, crude	6,511,208	202,899	9,652,366	261,078
Sulphate of	98,237,150	1,783,846	88,698,193	1,677,429
All other	16,858,875	761,611	19,067,144	959,595
	622,179,164	10,692,285	612,514,916	10,805,720

	1914		1915	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Potash:				
Carbonate of, crude	9,326,899	$265,158	5,386,719	$191,621
Caustic, not including refined	[b] 7,284,176	285,739	2,032,319	100,035
Cyanide of	417,139	59,278	871,871	134,123
Chloride of	371,521,920	5,745,385	129,339,840	2,296,606
Nitrate of, saltpeter, crude	2,230,528	74,869	6,855	400
Sulphate of	80,447,360	1,557,224	25,415,040	664,484
All other	14,590,437	756,320	7,502,806	377,955
	485,818,459	8,743,973	170,555,450	3,765,224

[a] Figures of imports furnished by Bur. For. and Dom. Commerce, U. S. Dept. Commerce.
[b] Including refined.

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FERTILIZERS.

Fertilizers imported for consumption into the United States, 1912–1915.

Fertilizer.	1912		1913	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Apatite	100	$1,400	2,962	$22,471
Bone dust or animal carbon, and bone ash, fit only for fertilizing purposes	117,717	878,686	35,012	851,136
Calcium cyanamid or lime nitrogen	9,311	493,519	26,729	1,410,348
Guano	19,128	329,624	16,674	518,429
Kainite	511,976	2,386,362	465,336	2,201,730
Manure salts, including double manure salts	171,757	1,797,057	223,687	2,245,509
Phosphates, crude	28,821	231,255	17,121	124,815
Slag, basic, ground or unground	12,596	114,300	13,186	130,455
All other substances used only for manure	127,932	2,660,887	154,729	3,314,460
	999,338	8,893,090	955,436	10,819,253

Fertilizer.	1914		1915	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Apatite	20	$300	.....	.....
Bone dust or animal carbon, and bone ash, fit only for fertilizing purposes	36,000	892,529	21,538	$543,243
Calcium cyanamid or lime nitrogen	21,793	1,119,785	30,043	1,322,195
Guano	25,335	761,562	9,874	220,768
Kainite	313,898	1,551,115	6,674	95,440
Manure salts, including double manure salts	168,969	1,846,475	13,753	200,584
Phosphates, crude	15,079	136,526	5,359	50,606
Slag, basic, ground or unground	9,199	105,272	76	1,343
All other substances used only for manure	171,603	3,507,875	72,848	1,535,860
	761,896	9,921,439	160,165	3,970,039

MATERIALS OF THE DOMESTIC FERTILIZER INDUSTRY.

Materials entering largely into the fertilizer industry in the United States, 1912–1915.

	1912		1913	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Imports:[a]				
Fertilizers	999,338	$8,893,090	955,436	$10,819,253
Potassium chloride	215,415	7,229,121	212,170	7,075,745
Potassium sulphate	43,856	1,783,846	39,597	1,677,429
Sodium nitrate	486,779	16,544,511	612,861	21,630,811
Domestic phosphate rock	2,973,332	11,675,774	3,111,221	11,796,231
	.....	46,126,342	.....	52,999,469

	1914		1915	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Imports:[a]				
Fertilizers	761,896	$9,921,439	160,165	$3,970,039
Potassium chloride	165,858	5,745,385	57,741	2,296,606
Potassium sulphate	35,914	1,557,224	11,346	664,484
Sodium nitrate	545,730	15,204,539	770,628	22,844,746
Domestic phosphate rock	2,734,043	9,608,041	1,835,667	5,413,449
	.....	42,036,628	.....	35,189,324

[a] Imports for consumption.

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WORK OF THE GEOLOGICAL SURVEY ON POTASH SALTS.

SCOPE OF THE WORK.

The work of the United States Geological Survey on the general subject of potash salts in 1915 included investigations in both the field and the laboratory. The work in the field included (*a*) stratigraphic investigation in the "Red Beds" region of New Mexico and adjacent States and continued study of the history of certain basins of evaporated lakes in Nevada, (*b*) drilling operations in Texas and Nevada, (*c*) examination of reported occurrences or prospects of potash salts and nitrates, (*d*) examination of alunite deposits, and (*e*) examination of greensand marl deposits. In the laboratory research work was done on the evaporation of bitterns and on certain of the potash-bearing silicate rocks. Many specimens that have been sent to the Survey by citizens from different parts of the country have been tested for potash salts and nitrates.

FIELD WORK.

The stratigraphic investigations of the "Red Beds" region of New Mexico and adjacent States were conducted by N. H. Darton, of the United States Geological Survey, who is now preparing a report on his work.

One result of the investigations of the "Red Beds" by Mr. Darton has been the selection of a site for an exploratory boring near Amarillo, in northwestern Texas, where drilling was begun in December. Buried salt deposits of great thickness are known to occur in this part of Texas, and the site chosen for the Survey test is near the locality at which potash-bearing crystals of red salt were obtained and studied by Dr. J. A. Udden,[1] of the Bureau of Economic Geology and Technology of the University of Texas. This boring should help to determine definitely whether or not potash salts are associated with the common salt in quantities large enough to be of commercial importance at this locality.

During the summer of 1915 four deep wells were drilled in the Smoke Creek Desert, Nevada, in search of buried saline deposits in the desert basin region. The results of this work were negative so far as the discovery of concentrated deposits of potash salts were concerned, but geologic information of value was obtained.

Besides this work with the drill a general investigation of recent developments and important occurrences of potash salts and nitrates has been made in several Western States. Many minor occurrences of potash salts and nitrates have been examined, but none have proved to be of any particular importance.

Some of the results of the Survey's alunite investigations, which have been obtained since the publication of this report for 1914, are briefly reviewed herein. Some recent analyses of the greensands of New Jersey are also given.

LABORATORY WORK.

Besides the field work by several geologists, some experimental work in the chemical laboratory of the United States Geological Sur-

[1] Udden, J. A., Potash in the Texas Permian: Texas Univ. Bull. 17, Mar. 20, 1915.

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vey has been carried on by W. B. Hicks on the evaporation of natural and artifical brines containing potash and by R. C. Wells on the extraction of potash from the wyomingite of the Leucite Hills in Wyoming. Hicks's results are referred to in the bibliography at the end of this report, and a preliminary statement of the work by Wells appears in the Survey's Professional Paper 98–D.

WORK OF THE BUREAU OF SOILS.[1]

The work of the Bureau of Soils in the investigation of potash salts in 1915 has been confined largely to continuation of its earlier work on the kelps of the Pacific coast. The bureau intends to continue its efforts to establish a potash-from-kelp industry on the western coast, but the exact lines of its procedure have not been fully determined and no details can be given out at the present time.

The bureau is continuing investigations on the possible utilization of feldspar as a source of potash, and it has just completed a plant at Arlington, Va., in which a number of processes will be tried out, but not enough information has yet been obtained to form any very definite conclusion.

POTASH IN TEXAS.

The report by J. A. Udden,[2] already referred to, contains data and general conclusions which have resulted from the examination of drill records, brines, and cuttings from 18 borings in the area of the Permian "Red Beds" of northwestern Texas and the adjoining part of New Mexico.

Potash was first found in the brine of the deep well at Spur, in Dickens County, Tex. This brine, which was tested as a result of the examination of the log and cuttings by Dr. Udden, then studying these materials under the auspices of the United States Geological Survey, was believed to have come from a depth of about 2,200 feet in the well.

Potash-bearing salts were found in making some tests for oil or potable waters on material from two wells in Texas, the Boden well, Potter County, and the Miller well, Randall County; and, it is believed, also from the Adrian boring, Oldham County. The Potter County well is 23 miles northwest of Amarillo, and the Randall County well is 16 miles southwest of this city. The air-line distance between the two wells is about 30 miles.

The largest showing of potash found in the Boden well, expressed as percentage of the soluble portion, was 9.23 per cent. The material yielding this quantity came from a depth of 875 to 925 feet. The portion analyzed was 87.24 per cent of the original sample.

The maximum showing of potash from the Miller well in Randall County was 10.50 per cent of the soluble portion, the sample containing the potash coming from a depth of 1,700 feet. The total soluble portion was 51.72 per cent of the original sample. Both the samples tested were, however, minute grains picked from portions of the cuttings which had been saved during the drilling of these wells, and it was impossible to determine at the time of their identification

[1] Statement to the Geological Survey by Milton Whitney, Chief of the Bureau of Soils of the U. S. Department of Agriculture.

[2] Op. cit.

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as potash whether these grains came from deposits of sufficient size to be of practical value or whether they are of mineralogic interest only.

Udden believes as a result of the finds made that the existence of potash salts is rendered so probable as—

to warrant the beginning of explorations to settle the question of its presence or absence. From the evidence now in hand it would appear most profitable, perhaps, to make the first test in the vicinity of the localities where potash salts have already been discovered. The data presented show that extensive salt beds underlie not only the greater part of the Panhandle, but that they extend south to Upton County and west into New Mexico.

He further concludes that—

the territory which appears from our present knowledge to give most promise is along the supposed axis of the basin, southward and a little westward from Boden, the Miller ranch, and Adrian.

From the explorations already made, it is evident that tests should extend to the greatest depth at which it may be considered profitable to work, say 2,000 feet. The "red salt" horizon in the Miller and the Boden borings will lie, it is believed, under most of the territory indicated, between 2,000 and 2,400 feet above sea level, or from 800 to 1,700 feet below the surface.

SEARLES LAKE, CALIFORNIA.

The American Trona Corporation was busy throughout 1915 with its projects for the manufacture of potash salts, both at Trona (Searles Lake) and at San Pedro, Cal. The company established in the fall of 1915 an experimental plant in New York City, consisting of evaporators, carbonators, and centrifugal and auxiliary machinery, for the purpose of experimenting on a large scale with the bitterns of Searles Lake. From Trona there were shipped to the experimental plant 60,000 gallons of bittern for a demonstration of their process on a large scale. In the concluding test made at the plant more than 600 gallons of bittern were used. The specific gravity of the Searles Lake bittern is 1.2974; hence, a gallon of the bittern weighs 10.8 pounds; and the quantity experimented with was therefore in excess of three short tons.

In the process of making a clean separation of the potassium chloride from the borax contained in the bittern there are two phases on which it is the intention to obtain patents.

In working with the Searles Lake bitterns artificial evaporation has to be resorted to but in a manner different from the methods used in salt or sugar works. One of the patents will describe the use of artificial evaporation in an apparatus very similar to the one used for producing common salt but duly modified to avoid losses in potassium chloride.

The company is erecting two plants—one at Searles Lake, or Trona, as the place is now called, and the other at San Pedro, near Los Angeles. The plant at Trona will produce the concentrated salts and these will be refined at the San Pedro plant. Barring accidents, the company expects to have potash and borax ready for market early in 1916, and already many applications for the potash salts have been received.

The product will at first probably contain an excess of 20 per cent borax, but as soon as the refinery at San Pedro is in operation the borax will be separated from the potash salts. Later on, when the first refinery unit is in running order, it is proposed to separate sodium

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carbonate and sodium sulphate, if any use can be found for the latter salts.

The evaporator house at Trona is a steel structure 109 feet high, and the boilers will have 2,000 horsepower. The spray pond for cooling condensing water is built entirely of reinforced concrete. A reinforced concrete chimney, 150 feet high and 9 feet in diameter in the clear on top, tanks, and crystallizing vats, triple-effect evaporators, and a traveling crane for the evaporator building are features of the equipment.

The erection of the refinery at San Pedro is also progressing rapidly. As soon as the first unit of this plant is in running order the company proposes to install a second unit and to increase the works.

The corporation had invested up to November 30, 1915, nearly $2,000,000 in this enterprise. The standard gage railroad, 30 miles long, connecting the deposit with the main line of the Southern Pacific Railroad at Searles, cost more than $600,000. The remainder has been spent on chemical investigations, on the experimental chemical plants, the assessment work on its claims required by law, and on other expenses incidental to construction at the deposit such as housing, fresh-water system, and so on.

It is estimated that the plants at Trona and San Pedro, when completed, will cost about $700,000, of which more than $200,000 already spent is included in the total expenditure of $2,000,000 up to November 30, 1915. Before earnings are available the expenditures will doubtless exceed $2,500,000. Future additions to the works will probably increase the total investment to more than $4,000,000.[1]

OWENS LAKE, CALIFORNIA.

Owens Lake, Inyo County, Cal., is the only existing remnant of the former lake system which comprised bodies of water in Owens Valley, Indian Wells Valley, Salt Wells Valley, the present Searles Lake, so-called, and in Panamint Valley. The lake itself is a large shallow body of water in the extreme southern part of Owens Valley and, according to the survey of February, 1913, has an area of 97.2 square miles and a maximum depth of water of 29.6 feet. The water, which is a dense brine, contains common salt, soda, borax, and other salines in solution. The lake has no outlet, and the volume of water in it depends upon the balance between evaporation and inflow.

In the processes that have formerly been used for extracting soda from the lake water the mother liquors that result from the crystallization of this compound and that contain considerable of the carbonate are returned to the lake, including the sodium chloride, borax, sodium sulphate, as well as all the potash salts. The soda which has been made from the lake waters near the little town of Keeler crystallizes out in the form of trona ($Na_2CO_3.NaHCO_3.10H_2O$); but in cold weather part of it is found as $Na_2CO_3.10H_2O$, which may include some sodium sulphate if care is not taken. The carbonate is converted by furnacing into the anhydrous carbonate (Na_2CO_3) which contains a minimum of 95 per cent soda.

[1] The figures cited were taken from a statement and memorandum by J. A. Brown given to the Senate Committee on Public Lands, February 2, 1916, and the general developments were noted in correspondence with officials of the company.

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The chemical composition of the water of Owens Lake is well known from several analyses, which agree fairly well with the exception of the determinations of boric acid. A recent analysis made by W. B. Hicks in the laboratory of the United States Geological Survey is as follows:

Composition of salts dissolved in water of Owens Lake, Cal.

[Sample collected by Hoyt S. Gale below water surface.]

	Percentage of anhydrous residue.	Recalculated to Na_2CO_3, free basis.		Percentage of anhydrous residue.	Recalculated to Na_2CO_3, free basis.
Cl	25.56	42.05	Mg		
SO_4	9.96	16.36	SiO_2	0.21	0.35
CO_3	22.18		Al_2O_3		
PO_4			Fe_2O_3		
B_4O_7	1.92	3.15	As_2O_3		
NO_3					
Na	38.07	34.64		100.00	100.00
K	2.10	3.45	Total anhydrous salts, percentage of original sample	10.95	
Li					
Ca					

Specific gravity of the solution at 21° C., referred to water at 20° C., 1.0977.

The potassium in the analysis given in the first column corresponds to 4 per cent potassium chloride, the form in which doubtless the greater part of the potash in the lake water occurs. After the removal of the sodium carbonate, the saline material has the composition indicated in the second column in the table above, and the potassium in the recalculated analysis corresponds to 6.56 per cent potassium chloride.

On the assumption that the lake level in October, 1912, was about 3,577 feet in altitude at the time the sample, the analysis of which is given above, was collected, a volume of approximately 1,000,000 acre-feet of water is indicated. A calculation from this quantity and the analysis quoted shows the lake waters to contain in round numbers as follows:

Approximate total content of chlorine, sodium, potassium, etc., in the water of Owens Lake, Cal.

	Short tons.
Chlorine	40,000,000
Sodium	60,000,000
Potassium	3,360,000
Anhydrous boric acid (B_2O_3)	3,070,000
Total anhydrous salts	160,000,000

These figures are considerably in excess of the estimates made by O. Loew,[1] who calculated 5,000,000 tons of potassium sulphate, but Loew's figures for volume were very moderate even for the data which he then had, and the estimates by Gale[2] given above have the advantage of much more exact volume computations.

The estimate that more than 3,000,000 tons of potassium is dissolved in the Owens Lake water is doubtless not far from correct, and, though very much lower in potash content than the brine of

[1] U. S. Geog. Surveys W. 100th Mer. Ann. Rept. for 1876, p. 190.
[2] Gale, H. S., Salines in the Owens, Searles, and Panamint basins, southeastern California: U. S. Geol Survey Bull. 580, pp. 259–260, 1915.

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Searles Lake, these waters may be considered among the important sources of potash salts.

The method of procedure at Owens Lake whereby the soda and potash salts will be recovered has been worked out by Carl Elschner by a process of fractional crystallization without the employment of artificial heat and the work has been undertaken by the Inyo Development Co., E. B. Davis, general manager. Vats were constructed for the solar evaporation of the waters in May, 1915, and late in September the first potash salts were made. The coming of cold weather made it impossible to work up all the concentrated potash liquors without the employment of artificial evaporation. The quantity of potash salts obtained to date, therefore, has been small and not more than a carload has been sold, but during the coming season it is expected that several thousand tons will be made and the experimental plant will be much enlarged.

GREAT SALT LAKE, UTAH.

The Utah Chemical Co. is erecting a plant on the shore of Great Salt Lake for extracting potash salts from the bitterns obtained as a by-product in the manufacture of solar salt by the Inland Crystal Salt Co. Building operations began about the middle of February, 1916, and according to Mr. L. C. Haskell, the manager of the company, production should soon begin. The plant is entirely experimental, and at this time the quantity of potash which will be produced is unknown. Magnesium chloride will also probably be produced.

It has been reported that the Diamond Match Co. will also extract potash salts from the water of Great Salt Lake. The plant which the company proposes to erect will be located at Grants, on the Western Pacific Railway, about 30 miles west of Salt Lake City, and near the south end of the lake.

PROCESS OF EXTRACTING POTASH SALTS FROM BITTERN.

Joseph A. Bradburn,[1] outlines a method for obtaining potassium chloride from brines or bitterns containing a combination of salts, such as sodium chloride, potassium chloride, sodium sulphate, magnesium chloride, and calcium sulphate. The water of Great Salt Lake is taken as a type.

The method consists in subjecting the bittern to a low temperature, as a result of which the greater portion of the sodium sulphate crystallizes out and is removed. The resulting liquor is evaporated and the greater part of the sodium chloride separates and is removed. Next, magnesium chloride is added to the mother liquor and the solution is subjected to evaporation in the hot. This results in the separation of the remaining sodium chloride, which is removed. The hot solution is cooled, as a result of which crude potassium chloride separates. The potassium chloride may be filtered off and washed. It forms a product 80 per cent pure, the remaining 20 per cent being composed of other salts. The mother liquor resulting from the separation of the potassium chloride is largely a solution of magnesium chloride, which may be used over again in the process.

[1] U. S. patent 1156388, dated Oct. 12, 1915.

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EXPERIMENTAL WORK ON RESIDUAL BITTERNS FROM CALIFORNIA SALT WORKS.

Edward B. Durham, of Berkeley, Cal., has experimented with the residual bitterns from the manufacture of salt on San Francisco Bay. He has separated the magnesium carbonate from these bitterns by using sal soda, and it appears from his work that this may profitably be done. His process leaves, however, the valuable potassium salts still to be recovered.

As the price of magnesium chloride has been high on the Pacific coast during 1915, separation of this chloride as well as magnesium sulphate from these bitterns has also been considered. The artificial carnallite produced in the process would of course be utilized.

POTASH SALTS FROM NEBRASKA LAKES.[1]

LOCATION.

The plant of the Potash Products Co., of Omaha, Nebr., was established in the spring of 1915 at Hoffland, a station 13 miles east of Alliance, in northwestern Nebraska, to obtain potash salts from the water of an alkaline lake in that region. Potash salts have been produced in this locality for about half the year.

There are many alkaline lakes in the Sand Hills region of Nebraska, which comprises 8,000 square miles covered by Tertiary and Pleistocene sediments. Niobrara and North Platte rivers form, respectively, the northern and the southern boundaries of the lake region; the western boundary is a line passing southwestward just east of Alliance, and the eastern boundary is a line passing southward through O'Neill. There are several small outlying areas.

The lake whose waters are being evaporated (Jesse Lake) is in the extreme western part of this district. Transportation facilities are good, as Alliance is on the Omaha-Seattle line connecting with the Chicago & Northwestern and on the Denver-Billings line of the Chicago, Burlington & Quincy Railroad, connecting with the Union Pacific.

Scattered among the Sand Hills are a great many depressions that have no outlet, formed apparently by wind erosion. They are locally known as "sinks" and many of them contain one or more lakes, the water in which is retained by an impervious layer of hard pan or mud. The large and deep bodies of water are only slightly alkaline, but some of the smaller ones are comparatively rich in salts.

COMPOSITION OF WATER.

Twenty-four analyses, some of them made by the United States Geological Survey and some by J. H. Show, of the Potash Products Co., indicate that the percentage of dry salts (salinity) in the lake waters may run as high as 13.55 per cent, and the content of potassa in the dry salts of the 24 samples ranges from 8.96 to 35.85 per cent. No samples containing less than 2 per cent potassa are included in the 24 analyzed. Another set of analyses by J. H. Show shows that the brines carry essentially potassium and sodium carbonates and sulphates, with the soda usually in excess. Chlorides, except in the waters of a few lakes, are in minor quantities.

[1] Abstracted from a paper by Victor Ziegler entitled, The potash deposits of the Sand Hills region of northwestern Nebraska: Colorado School of Mines Quart., vol. 10, No. 3, pp. 6-26, October, 1915.

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The samples collected by the United States Geological Survey in the search for potash a few years ago comprise muds, brines, and saline crusts. In addition to the samples included in the tables below 94 others were collected; but as they contained less than 3 per cent of dissolved material (87 of them contained less than 2 per cent) further analysis of their potassium content was not made. The following analyses were published by the Survey in 1914.[1]

Potash analyses of muds from western Nebraska.

No.	Source of sample.	Soluble portion expressed as per cent of sample.	K_2O content expressed as per cent of soluble portion.
26	1 foot below surface of Jesse Lake, 40 feet from shore	9.35	25.42
77	1 foot below surface of flat, one-fourth mile north of railroad, 2 miles east of Reno post office	3.04	14.80
112	Lake at Lakeside	3.58	12.03
115	4 feet below surface of Jesse Lake	4.63	28.92
116	7 feet below surface of Jesse Lake	4.07	24.78
126	Lake in sec. 1, T. 21 N., R. 46 W	3.47	13.20
	Average of 6 samples	4.69	19.86

Potash analyses of brines from western Nebraska.

No.	Source of sample.	Dissolved salts (dried at 105° C.) expressed as per cent of original sample.	K_2O content expressed as per cent of dissolved salts.
24	Shallow pit at edge of Jesse Lake	12.31	34.81
27	Pit 4 feet deep in Jesse Lake, 40 feet from shore	14.14	26.40
62	Pond 1 mile southwest of house on Star Ranch, sec. 17, T. 26 N., R. 43 W.	3.21	35.85
73	Pond in sec. 19, T. 26 N., R. 44 W. (small)	8.15	15.50
74	Pond in sec. 19, T. 26, N., R. 44 W. (large)	4.70	31.40
79	Pond at F. C. Taylor's place, 3 miles east of Reno post office	7.20	23.14
85	Pond in northeast corner sec. 20, T. 26 N., R. 44 W	4.56	31.56
118	Middle of Jesse Lake	13.55	29.97
119	McCarty Lake, sec. 17, T. 23 N., R. 46 W	8.83	30.62
120	Pond ½ mile southeast of McCarty Lake	8.11	19.82
123	Richardson Lake, secs. 4 and 5, T. 22 N., R. 46 W	7.57	14.44
125	Lake in sec. 1, T. 21 N., R. 46 W	3.33	16.61
130	Thompson Lake, 15 miles southeast of Alliance	4.30	19.68
	Average of 13 samples	7.69	24.91

Potash analyses of saline residues from western Nebraska.

No.	Source of sample.	Soluble portion expressed as per cent of sample.	K_2O content expressed as per cent of soluble portion.
25	Crust on southeast margin of Jesse Lake	34.06	21.00
75	Alkali from road 8 miles west of north of Lakeside	4.62	6.16
78	Alkali sand south of railroad, 3½ miles east of Reno post office	8.51	11.27
94	Surface incrustation east end of Crevath Lake	34.05	17.17
113	Surface incrustation south edge of pond 1 mile west of north of Lakeside	30.85	2.40
117	Surface incrustation, Jesse Lake	20.25	17.39
132	East pond on Cluff place	8.97	29.70
134	Pond 1½ miles west of preceding	15.12	12.76
	Average of 8 samples	19.55	14.73

[1] Hance, J. H., Potash in western saline deposits: U. S. Geol. Survey Bull. 540, pp. 457–469, 1914.

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ORIGIN OF SALINES.

Hance [1] points to the marked similarity of the complete analyses of these saline lake residues to the analyses of leachings from wood ashes and suggests that wood ash is one of the sources of the alkali. The Sand Hills and adjoining meadows at one time supported a generous growth of brush and timber, and the region has reached its present condition through repeated destructive forest fires. Prairie fires have also been of frequent occurrence, and the natural leachings of these ashes may explain the concentrates in the depressions. This conclusion has also been reached by Ziegler, who thinks, further, that some alkali may also have been leached from the underlying rocks.

EXPLOITATION.

The analyses given show that the waters, muds, and crusts of Jesse Lake have the highest content of potash and this is the only lake from which potash salts are now obtained. The lake covers 240 acres and is 3 miles north of Hoffland. It is underlain by a dark greenish-colored mud, beneath which is a layer of sand, 20 feet thick in places, charged with strong brine. This sand rests on hardpan composed of dense, impervious marl, said to be rich in magnesia.

The brine that impregnates the sand shows a greater degree of concentration than the surface water, and sand pumps are therefore used to pump it. A certain quantity of surface brine is drawn in by suction, as is indicated by the lowered saline content of the brine delivered by the pump. The water as pumped is delivered to a solar tower in which the liquid flows by gravity over 20 wooden partitions ranged one below the other. The degree of evaporation obtained in the solar tower depends on temperature, wind, humidity, and possibly other factors and varies from 5 to 20 per cent.

The brine is pumped from the solar tower through 2 pipe lines to storage tanks at the main plant at Hoffland, 3 miles south of the lake. Here the company plans to erect a second tower to concentrate the brine still more before it goes to the storage tanks. The construction work on this second tower was begun in November, 1915.

From the storage tanks the brine is fed into steel evaporating vats, which are ranged in 2 sets. The first set consists of 4 vats, 12 by 16 by 4 feet, in which the preliminary concentration takes place. The second set, consisting of 2 vats, 12 by 12 by 4 feet, is for the final crystallization of the dissolved salts. The vats are heated by steel coils, suspended near the bottom. The crystallizing vats have a perforated steel plate in the bottom. The crystallization proceeds very rapidly, and as the salts settle out they mechanically retain some of the strong brine. The portion of the brine which escapes through the perforations at the bottom of the vats is caught in the sump and pumped back into the preliminary concentrators. After crystallization has proceeded to the proper point and the heat is turned off, the excess brine is pumped into storage tanks to be shipped subsequently in this raw state. The salts, which includes a considerable proportion of the residual bittern left in the crystallizing tanks, are shoveled upon a loading platform, where they drain and are loaded into tank cars. As shipped, they carry 30 to 40 per cent of brine.

[1] Op. cit., pp. 465–467.

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The company plans to equip the plant with vacuum pans and rotary driers to handle the wet salts. The delivery of this material was expected last November. As soon as the modern machinery is installed, the capacity of the plant will be increased to about 75 tons of salts a day. For the first 4 months the production averaged about 7 tons of salts a day and about 30 tank cars of brine a month. The company has made no attempt to separate the potash salts, because the demand for both the salts and the brine has been greater than the total production. The salts as shipped are mixed with tankage and used for fertilizers.

AVAILABLE SALINES.

The exact number of alkaline lakes in the western region is not known, and most of those known are not rich enough in potash to be of commercial importance. Perhaps not more than 10 per cent carry alkali enough to justify concentrating it on a commercial scale. None of the lakes with strong brines are large. Jesse Lake, which has an area of 240 acres, has been estimated to contain about 100,000 tons of saline material. As the individual lakes are generally small the erection of a special evaporating plant for one lake would hardly be considered, but a plant centrally located might be able to work profitably the brine from several small lakes. In any case operations could be carried out only on a small scale, as the total accumulation of saline material is small.

OTHER SALINE LAKES OR DEPOSITS.

Alkali Lake, Oreg.—There is a notable deposit of soda in and around a shallow and variable lake of strong brine in Alkali Valley, in southern Oregon, which occupies the bottom of one of the typical desert basins of this part of the Great Basin region. The alkali occurs as a crust on the surface of mud in and about shallow saline ponds, and there are "pot holes" about the margin of the deposit in which almost pure soda crystallizes. These "pot holes" have been worked for soda in a small way, and the deposit as a whole has been taken up by a company which designs to work it for soda and other possible products. Naturally, attention has been directed to this deposit as a possible source of potash.

This deposit was examined in August, 1915, by Hoyt S. Gale, who took samples of the brines and salts. Reports of potash tests made on these materials had not been very encouraging, but complete evidence on this point was desired. The results do not seem to offer much promise except, of course, that potash may be recovered in conjunction with other salts. For example, the brine from a pool known as Little Alkali, which is probably the largest body of open water, carries 10.63 per cent dissolved matter (ignited residue) in which potash ran 3.25 per cent as potassium, or 6.19 per cent if figured as potassium chloride. This content of potash is somewhat higher than that commonly obtained in such brines, but is not comparable, for example, with that in the brine from Searles Lake, in southern California, and the brine from Alkali Lake was less than half saturated.

Abert and Summer lakes, Oreg.—Reports are published from time to time relating to a project for extracting salt, soda, potash, and other

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mineral salts from the waters of Abert and Summer lakes, in southern Oregon. These lakes, which are of considerable size, carry alkaline salts in rather dilute solutions, ranging according to analyses available from about 3 to 8 per cent in Abert Lake and from about 2 to 4 per cent in Summer Lake. Although the aggregate quantity of salts in these waters is undoubtedly very large, the waters are only about as concentrated as ordinary sea water, and the potash, as shown by authoritative determinations, is only slightly greater than that contained in sea water. Thus, soda might be recovered from these waters by solar evaporation much as salt is now recovered from sea water, and in this connection it is also conceivable that potash might be recoverable as a by-product.

Salduro Salt Marsh, Utah.—The expected extraction of a by-product from the water of Great Salt Lake has revived interest in the possible extraction of potash from the salts or brines of the Salduro Marsh, also in Great Salt Lake Basin, west of Great Salt Lake. This deposit lies directly on the main line of the Western Pacific Railway and has been worked somewhat as a source of salt. It was examined with special reference to the possibility of obtaining potash there in October, 1914, by Hoyt S. Gale for the Geological Survey. Mr. Gale contributes the following notes:

Several shallow holes were bored through the hard surface salt crust that forms the floor of this basin and into the underlying mud. Analyses of samples taken from these borings show that the surface salt is comparatively pure sodium chloride containing an exceedingly small quantity of potassium. The water-soluble potassium contained in the underlying muds ranges from about 1.8 to 3.5 per cent (expressed as K) of the dissolved salts included in the mud, which constituted from about 12 to 15 per cent of the original samples taken, some 5 to 7 per cent of the samples being water. Brine was found both in the salt crust and in the underlying mud, and on analysis proved to be saturated solutions carrying 25.68 to 26.85 per cent dissolved salts, of which 2.8 to 4 per cent was potassium (expressed as K). This is 0.75 to 1.03 per cent of potassium in the original solution, or only about half the potassium content of the brine in Searles Lake, Cal. It is, however, about double the potash content of the water of Great Salt Lake (0.34 per cent potassium in the sample of October, 1913), which, however, is not usually a saturated solution. The brine at Salduro appears to flow freely into holes cut into the salt or mud, but it seems that the supply must be small and this might also prove an important fact in any contemplated enterprise dependent on large and regular supply of the brine. Again, though the potash prospects of Salduro are not believed to be very promising, it is possible that potash might be produced there in some form, perhaps as a by-product of some other industry, or perhaps only under the stimulus of present abnormal conditions.

Virgin River salt deposits, Nevada.—Remarkable cliffs of salt are exposed in natural outcrop along the valley of Virgin River in southern Nevada. Although these have attracted attention from the days of earliest exploration in the West, they lie in a region that is not readily accessible, and the salt has not been utilized except locally in a very small way. This region was visited in September, 1915, by Hoyt S. Gale, by whom the following notes are contributed.

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The salt ledges are exposed at several places along both sides of the Virgin River valley between St. Thomas and the mouth of the Virgin at Colorado River, the outcrops extending over a distance of at least 12 miles. Similar outcrops are also reported 30 miles east of St. Thomas, so it appears evident that the salt was originally a continuous and widely distributed stratum laid down during the formation of a certain part of the sedimentary rocks of this part of the country. The salt is associated with a great thickness of gypsum and gypsiferous shales, and is included in a series of characteristically red shales, sandstones, usually referred to as "Red Beds," of Triassic or Permian age. The beds including the salt have clearly been very much faulted and folded, so that the present outcrops represent disconnected parts of them, and it is also evident that only in exceptional positions has the salt itself been preserved in open exposures or under shallow cover above ground-water level.

It is natural to look to such a region as this for the possible occurrence of potash-rich portion of these saline deposits. The largest salt ledge exposes an almost vertical face of solid crystalline salt, representing a bed at least 100 feet in height, in nearly horizontally bedded position. The base is concealed, and the bed may be actually much thicker. The top of the salt is very sharply defined, and the bed is overlain by reddish clay and higher in the section by gypsum, shale, and red sandstone, the beds including also an interbedded flow of dark lava. Samples of the salt dug from the face of this cliff have been analyzed with the following results:

Tests of samples from Salt Cliff, 3½ miles south of St. Thomas, on Virgin River, Nev.

	Distance below top of cliff.	Soluble portion.	KCl in soluble portion.
	Feet.	*Per cent.*	*Per cent.*
1	60	94.98	0.29
2	50	98.52	0.08
5	40	97.12	0.09
6	35	98.88	0.08

The great mass of crystalline translucent salts appears to be rather uniform in composition, though it contains an interbedded layer of gypsiferous clay a few inches thick. So far as present evidence goes, therefore, it appears to carry no potash-rich layers, although it might be worth while to sample these exposed ledges even more systematically.

The other salt cliffs or exposures down the Virgin River valley, including the last one just below the "Narrows," about 6 miles above the mouth of the Virgin, were examined and some samples taken, with results similar to those already given. A salt well near Colorado River below the mouth of the Virgin was also visited and sampled, with the following results:

Tests of samples from salt well on Colorado River.

	KCl in soluble portion (per cent).
Brine containing 30.77 per cent of dissolved salts	2.39
Efflorescence about rim of well containing 33.31 per cent of water soluble matter.	1.68

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Some samples of the river waters above and below this salt field were taken on the chance that some indication concerning salt beds that were being leached might be obtained.

Tests of samples from lower Virgin River valley, Nevada.

	Total soluble salts.	KCl in total salts.
	Per cent.	*Per cent.*
Surface stream in gypsum beds on "Diehl potash claims"	0.97	3.07
Seep in Bitter Spring Draw	.38	7.82
Water from shaft on "Diehl potash claims"	4.19	.28
Virgin River water, below the salt cliffs, 5 miles above mouth	.365	Not det.
Virgin River water, below the salt cliffs near mouth	.38	4.93
Colorado River, water just above mouth of Virgin River	[a].102	Not det.

[a] This result may be too high, as sample was difficult to filter.

Probably the object of these last tests was not accomplished because the test was not complete enough. One result, that from the seep in Bitter Spring Draw, which gave 7.82 per cent of potassium chloride in the salts dissolved in a rather dilute water, may be of some significance. Of itself, of course, so dilute a water could be of no value, and the quantity of the flow is insignificant.

Potash may be present in this area, in association with the salt and gypsum, but no very definite indication of its existence, especially in commercial quantity, has been brought to light.

ALUNITE NEAR MARYSVALE, UTAH.

PRODUCTION.

The year 1915 was notable in the history of the potash-salts industry in the United States, for in that year potash salts were first obtained on a commercial scale from alunite, a hydrous sulphate of aluminum and potassium ($K_2O.3Al_2O_3.4SO_3.6H_2O$), and shipped from the plant of the Mineral Products Corporation at Marysvale, Utah. The production is, of course, small, but the enterprise that led to the establishment of the industry is worthy of recognition. This is among the first outputs of potash from a mineral source in the United States and, so far as known, it is the first production of potash salts from alunite in the world, as the foreign deposits have been worked primarily for potash alum and not for potash salts alone.

PROCESS OF PRODUCTION.

The following description of the process of preparing potassium sulphate from alunite at Marysvale, Utah, is based on information furnished to V. C. Heikes, of the United States Geological Survey.

The mill is about 5 miles southwest of Marysvale and 2 miles west of Sevier River, near the mouth of Little Cottonwood Canyon. The alunite vein, which is on the Gillan-Custer claims, is 4 miles farther west by wagon road. The mined alunite is conveyed by an aerial tramway 6,200 feet long, with a fall of 1,900 feet, to a bin at the creek level, from which it is carried by wagons over a down-grade road of 3½ miles to the mill. The tramway, under present conditions, has a rated capacity of 12½ tons of alunite an hour.

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From the ore bins at the mill the alunite passes through a gyratory crusher, next through a set of rolls, from which it is delivered to a storage bin. After being mixed with powdered slack coal, it is fed into a rotary kiln, where it is roasted. The roasted material is elevated to a storage bin, from which it is drawn off into a digester. In the digester it is mixed with water and the sulphate of potassium is dissolved out. The charges from the digester are stored in wooden tanks. From these tanks the mixture is pumped into a filter press, where the insoluble alumina and the water-soluble potash are separated. The solution is then evaporated in a triple-effect vacuum pan, and the potassium sulphate which separates out is drained, dried, pulverized, screened, and sacked for shipment.

Boilers having a rated capacity of 600 horsepower produce steam for the three engines that drive the machinery of the plant. The exhaust steam is used for evaporating the solutions and drying the product. Slack coal is used for fuel.

The capacity of the first unit of the plant is estimated to be 25 to 35 tons of potassium sulphate a day. In addition to this valuable product, the operators expect returns from the filter cake left after the potash solution has been removed from the calcined material. This cake consists of nearly pure alumina.

The mill is the first to be built in the United States to treat alunite. Its operation was begun on September 15, 1915, when some alunite was put through the crusher. Each part of the machinery was gradually tested thereafter until, by October 6, fully 200 tons of alunite had been distributed through the plant. On October 5 about 20 tons of filter cake, reported to contain 65 per cent of alumina (Al_2O_3), was discharged, and about 85,000 gallons of the saturated solution of potassium sulphate had accumulated in the evaporators, which were placed in commission on October 6. On October 7 the first potassium sulphate was produced. On October 20 the first carload of 28 tons of potassium sulphate, averaging 95.39 per cent pure, was shipped.

The recent developments, together with a review of the geology of the deposits near Marysvale and Beaver, Utah, have been summarized by G. F. Loughlin,[1] from whose report the notes on the method of operating the plant were taken. This report is still available for distribution.

OTHER OCCURRENCES OF ALUNITE.

One of the largest exposures of alunite outside of the Marysvale district, Utah, is that in the Las Vegas district, in southern Nevada. This deposit has been examined and sampled by Hoyt S. Gale for the Geological Survey, as well as by others working for private interests. The following statement has been contributed by Mr. Gale:

Although there is evidently a great quantity of alunite and alunite-bearing rock at this locality, most of it seems to be in veins so small or so widely disseminated in the country rock that it is doubtful whether it can be worked, as is the deposit at Marysvale.

The alunite deposits occur just south of a point known as Railroad Pass, 22 miles southeast of Las Vegas, about half a mile south of the rim of the broad valley that extends southeastward from this town.

[1] Recent alunite developments near Marysvale and Beaver, Utah: U. S. Geol. Survey Bull. 620, pp. 237-270, 1915 (Bull. 620K).

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The alunite occurs principally in a series of little hills which lie at the very base of the steep escarpment of volcanic rocks at the extreme upper margin of an alluvium-filled valley. These knobs or hills appear to be erosion remnants of silicified parts of a much altered porphyry. Though alunite is most conspicuous in the zone of alteration and silification represented by these knobs, the country rock thereabout is very generally altered and alunitized, as has been noted by persons prospecting for minerals at many other points.

The study of the samples collected at the Las Vegas alunite locality has not been completed, but chemical determinations made to show the potash content of samples indicate that the general run of rock as it would have to be mined at this locality would probably not average over 2½ per cent potash (as K_2O), or at the most 3½ per cent. The actual determination on one average sample of cuttings from a tunnel on the property gave 2.2 per cent K_2O, or 4.06 per cent K_2SO_4 in the water leach after ignition 1½ hours.

The alunite deposits of Nevada and the potash alum deposit near Silver Peak have been examined by Victor Barndt, of Tonopah, and his associates. Field examinations have been made and samples collected under the direction of E. E. Free at Bullfrog, Cuprite, Goldfield, and Silver Peak, near the railroad station of Blair Junction.

The several samples collected in the Bullfrog district showed only a small quantity of alunite and were therefore not analyzed in detail.

The material from Cuprite is an alunitized rhyolite tuff, with which is associated some free sulphur. A number of exposures have been located in the vicinity of Cuprite. Most of the material is poor in alunite, and laboratory tests reveal the alunite to be of the soda-bearing variety and to contain as much soda as potash. The conclusion has been reached that the material is of no importance as a possible source of potash.

The mineral alunite forms a substantial part of the gangue of some of the ores at Goldfield, Nev. It occurs associated with altered rhyolite, dacite, andesite, and latite, but, unlike the occurrence at Cuprite, no free sulphur is present. Large quantities of fairly pure alunite are available in this district in metal mining, especially on Preble Mountain, where the alunite is associated with dacite and andesite. Some might be obtained incidental to metal mining operations. Experiments, however, show that this alunite, like that at Cuprite, is of the soda-bearing variety and it is not believed that it will prove a profitable source of potash salts.

Potash alum.—The material at the Silver Peak deposit is potash alum (kalinite), with which sulphur is associated. The alum itself occurs as veins, some of them several inches thick, which split and ramify irregularly through the altered rhyolite. Analyses show that the material of the veins is practically pure potash alum, but the soluble material in the adjacent impregnated rocks includes some soda. There is little alunite present.

Some development work has been done on the deposit and it has been located and relocated many times and prospected as a sulphur mine, but the work done has not sufficed to reveal its entire extent. The material is believed to be of value as a source of potash and an

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option has been taken on the property by Victor Barndt and his associates. It is expected that development work will be done very early in 1916 to determine the exact extent of the deposit and the average grade of the potash alum.

PROCESSES OF TREATING ALUNITE.

A process has been patented by Charles H. MacDowell,[1] which relates to the treatment of alunite, alum rock, alum stone, etc., for the recovery of the contained alkaline salts, principally potash salts.

The alunite is calcined at a temperature sufficiently high to drive off the sulphur trioxide. The residual product contains alumina, insoluble in alkali, potassium sulphate, soluble in water, and a small quantity of sodium sulphate. Instead of leaching out the soluble salts the patented process involves raising the temperature of the calcined material so that they are driven off by volatilization. In practice it is found that a temperature ranging from 1100° to 1600° C. is sufficient to volatilize all the potash salts and with them the small quantity of sodium salts that may be present. When the operations are conducted at 1600° C., only traces (not more than 0.5 per cent K_2O and Na_2O) are left in the calcined alunite treated. The volatilized alkaline salts may be recovered as such in solid form by conveying them into a cooling flue where they deposit.

The process avoids leaching and may be important in localities where water is scarce.

The patent also relates to the discovery that if calcined alunite in a finely divided condition is mixed with 20 to 50 per cent carbon in the form of powdered coal, coke, or lampblack the temperature of volatilization may be considerably lowered and may begin as low as 800° C.

A process of obtaining potassium sulphate from alunite, patented by George S. Morgan,[2] consists of grinding alunite, mixing it with lime in the proportion of four parts of alunite to one of lime, and furnacing the mixture in a rotary furnace. The heat is directed into the discharge end of the furnace and the temperature is raised to 1,200° to 1,800° F. and maintained until the reaction is complete.

The roasted mixture is placed in leaching vats while still hot. Water is added and the mixture is agitated by live steam. The partly saturated solution is directed to the next vat and again agitated and this process is repeated until the solution is concentrated at a temperature of 200° F. The solution next goes to crystallizing vats, where it cools and the salts separate. The mother liquor is then used to dissolve potash salts in that leaching vat containing the roasted alunite which has been leached the most; it passes then through different vats in succession to the vat containing the roasted material which has just come from the furnace. In this way it becomes thoroughly saturated. The potassium sulphate crystals are then removed, dried, and ground, or otherwise treated.

A point that is emphasized in connection with this process is that the sulphur dioxide produced combines with the lime and none passes into the air.

[1] U. S. patent 1136549, dated April 20, 1915.
[2] U. S. patent 1161239, dated November 23, 1915.

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POTASH SALTS FROM SILICATES AND OTHER SOURCES.

GENERAL CONDITIONS.

The subject of the extraction of soluble potash salts from the silicates, such as feldspar, leucite, and sericite, and from greensand has been discussed ever since the question of a domestic supply of potash was broached. Many patents for such processes have been issued, but the problem of doing the work at a profit is still to be solved. One difficulty is the location of large deposits of uniformly high-grade material. Large deposits of feldspar of uniformly high grades are not plentiful. Of leucite and greensand there is abundance; and the supplies of greensand especially are very accessible. Whether the greensand will prove to be of sufficiently high grade or whether it can be brought up to workable grade is not known.

All processes for extracting potash salts from the silicates include both the mining and transportation of raw material and also the accessory materials needed for the reactions. Further, in the practical manipulation of all the processes devised, there is generally involved fusion, sublimation, extraction, filtration, concentration, crystallization, drying, grinding, sorting, and bagging, a series of operations which will make potash so expensive that under normal trade conditions it can never hope to compete successfully with German potash salts at the prices at which they can be sold in this country.

W. H. Bowker[1] has said that

> The (German) potash industry has been one of the most profitable in the world. It is said that muriate of potash, the standard grade (50 per cent K_2O), can be mined and delivered at the seaboard of this country for $15 a ton and show a handsome profit. I am told that it was stated in debate in the Reichstag in 1910 that the best mines in Germany could mine the mineral and refine it for about $8 a ton. The price in cargo lots is from $33 to $34 per ton delivered at seaboard. Through the German Kali Syndicate the production of the mines is limited by allotment and the price is arbitrarily fixed. It is stated that there have been more than a hundred well-equipped mines, with a capacity equal to six times the world's consumption.

Only those who have experimented with the processes of deriving potash salts from the silicate rocks and minerals on a large scale are in a position to speak with authority on costs, and not much has been published on this phase of the work. A. S. Cushman and G. W. Coggeshall[2] have discussed costs and estimate at $28.80 per ton the cost of potassium chloride of 80 per cent grade (50 per cent K_2O). This corresponds to a cost of 2.88 cents per pound of K_2O. If German potassium chloride of the 80 per cent grade can be delivered at our seaboard for $15 per ton and show a handsome profit, the hope for the successful establishment of a domestic potash-salts industry near the Atlantic seaboard, except during abnormal times like the present, seems rather remote. The farther inland and the higher the freight rates the better the opportunity for a domestic industry to compete; but the fact must be borne in mind that the largest domestic consumption of potash salts is in the Eastern and Southeastern States, where freight rates from seaboard cities to inland points are not high.

In the preparation of soluble potash salts from the silicate rocks, especially for the fertilizer trade, which consumes more than 90 per

[1] Jour. Ind. and Eng. Chemistry, vol. 7, No. 1, pp. 59–61, Jan., 1915.

[2] From a paper presented before the Seventh Ann. Mtg. Am. Inst. Chem. Eng., Philadelphia, Pa., Dec. 2, 1914, reprinted in the American Fertilizer, Dec. 12, 1914.

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cent of the imported material, the problem is not necessarily one of extraction of the pure salts, though the demand for these is acute in certain branches of the chemical industry. If the potash is rendered soluble in the mass, this mass can be used in mixed fertilizers. A product, however, of too low grade will not be in demand when conditions are normal, for the trade in German potash has resulted in a demand for the higher grades.

A fact worthy of serious consideration is that most of the processes devised will yield by-products of value; indeed, the obtaining of a by-product of value may be the determining factor between profit and loss in practically all of them.

LEUCITE ROCKS, WYOMING.

A. H. Rogers,[1] of Boston, has outlined some experiments with the potash-bearing rocks of the Leucite Hills, Wyoming, made with the object of abstracting soluble potash salts from them on a commercial scale. Both the wet and the dry methods of treatment were tried. Leucite, in contrast with feldspar, is very easily decomposed, and, unlike most silicates when decomposed by wet acids, it yields its silica in the granular and not in the gelatinous condition, a fact which makes the wet treatment possible. It was found that when leucite rock was treated with sulphuric acid to which a little hydrochloric acid had been added complete solution of the bases resulted. It was thought that this process might solve the problem, but the resulting sulphates were about as hard to separate as were the constituents in the rock itself. The digestion of the leucite rock with caustic lime under high pressure was also tried, and the procedure was varied by using caustic soda and even sodium chloride, with the idea that the sodium might replace the potassium more effectively than lime. The results from these tests were not encouraging.

The rock was next treated with sulphur dioxide gas at a temperature of 1,200° C., and the Hargraves process, which is used for making sodium sulphate from common salt by passing steam and sulphur dioxide over it at a temperature of about 500° C., was also employed. The results from these tests were likewise not encouraging and for the time being experiments by the wet method have been discontinued.

Almost all the present known dry processes that appear to offer any possible hope of success have been tried, and it has been found that when a mixture of leucite rock, lime, and gypsum is heated to the proper temperature, the potash can be quantitatively extracted in the form of the sulphate. With some of the experiences of the cement manufacturers in mind, in which quantities of alkalies contained in limestone are volatilized, many experiments were made, but they were not completely successful, as at times much of the potash would be driven off, at other times very little. Heating the leucite rock with phosphate rock produced no results. The Cowles process, devised to extract alumina from clay, was also tried. In this process, a mixture of salt and clay is compressed into briquets and heated, whereby hydrochloric acid is given off and alkali-silico-aluminate formed; this compound is then decomposed by heating with limestone to form a lime silicate, a soluble alkali aluminate being left. Briquets were made and heated in the Cowles furnace, but very unsatisfactory results were obtained.

[1] Min. and Metall. Soc. America Bull. 83, vol. 8, No. 4, pp. 93-95, Apr. 30, 1915.

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The conclusion has been reached by practically all the investigators that the commercial treatment of the silicates is hopeless unless alumina can be recovered also, a conclusion shown in recent patents, which all aim to produce something in addition to potash salts. In common with many other experimenters, F. A. Rody found that when silicates are heated with limestone the potash is freed, but he also found that if the lime is in the proper proportion all the bases are set free, with the exception of magnesia. The alkali combined with alumina, being soluble, may be leached out. Rogers[1] says:

> The ability to recover alumina in such a simple way is, we believe, the solution of the problem. The process consists of grinding the mixture of leucite and limestone in proper proportions, just as in cement manufacture, and furnacing it in a cement kiln. The clinker produced is somewhat similar to cement clinker and it is simply ground and leached. Nothing but alkali and alumina go into solution and these can be separated just as in bauxite refining. The resulting alumina is just as good as that produced from bauxite. We have been doing this for about a year now in a small experimental kiln; and while, due to difficulty of temperature control, we do not always get high extraction, we consider it possible that with the uniform conditions possible of maintenance in a large furnace, we can recover 75 to 80 per cent of these two substances.[2]

SERICITE.

Sericite, a variety of muscovite or potash mica, is a fine scaly or fibrous mineral. Chemically it is an orthosilicate of potash and alumina, containing in the theoretically pure mineral 11.8 per cent of potash (K_2O). It has been considered as a source of potash salts and some of it has been experimented with.

Some of the best known sericite deposits and those spoken of as sources of potash are at or near Jasper, Pickens County, Ga. They occur in beds or lenses of practically pure sericite; some beds at least 5 feet thick have been measured and thicker ones have been reported. They are in places continuous over considerable areas.

The sericite is very uniform in character, both physically and chemically, both below, above, and at the water level. Only at the surface, where it is disintegrated by weathering, does it vary in appearance and composition.

The following analysis of sericite was sent to the Survey by Prof. S. W. McCallie, State geologist, Atlanta, Ga.:

Analysis of sericite from the William Richards property, Pickens County, Ga.

[Edgar Everhart, analyst.]

Moisture at 100°	0.12
Loss on ignition	3.96
Soda (N_2O)	.20
Potash (K_2O)	10.75
Lime (CaO)	.00
Magnesia (MgO)	.40
Alumina (Al_2O_3)	34.29
Ferric oxide (Fe_2O_3)	2.96
Ferrous oxide (FeO)	.72
Manganous oxide (MnO)	Trace.
Titanium dioxide (TiO_2)	.56
Silica (SiO_2)	46.17
	100.13

[1] Op. cit.

[2] See also Rody, F. A., U. S. patent 1151533, dated August 24, 1915.

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GREENSAND.

The greensands of New Jersey, Delaware, and Maryland are found in Cretaceous rocks. They contain glauconite, a hydrous silicate of potash and iron, which forms a large part of several Cretaceous formations in these States. The greensand-bearing formations extend southwestward across New Jersey in Monmouth, Burlington, Camden, Gloucester, and Salem counties, and continue southwestward into Delaware and Maryland.

The glauconite in New Jersey is found in the Marshalltown, Navesink, Hornerstown, and Manasquan formations. These subdivisions of the Cretaceous system may be readily followed on the geologic map [1] issued by the Geological Survey of New Jersey, and are described in detail in the report [2] that accompanies that map.

Though the four greensand-bearing formations do not consist entirely of greensand they nevertheless contain greensand beds so thick and so widespread in areal extent that they are of special interest as sources of fertilizer. In former years large quantities of greensand were dug from them for use in agriculture and they still furnish a small quantity, a little of which is used in some prepared fertilizers. In recent years, however, greensand has been supplanted by more concentrated commercial fertilizers.

The greensand contains both potash and calcium phosphate, and some of the so-called shell marls contain also calcium carbonate, all three of which are of value as fertilizer. Samples of these greensands collected in January, 1916, were analyzed by W. B. Hicks to determine their content of potash. The results of these analyses are given below.

Potash in greensands of New Jersey and Delaware.

Samples collected by W. C. Phalen.

No.	Percentage of potash (K_2O).	No.	Percentage of potash (K_2O).
1	3.54	8	5.14
2	4.90	9	6.26
3	4.86	10	5.92
4	4.28	11	6.22
5	3.74	12	5.76
6	4.22	13	3.36
7	4.22		

1. Northeast of Farmingdale, Monmouth County, N. J.
2. East of Marlboro, Monmouth County, N. J.
3. Near Marlboro, Monmouth County, N. J.
4. Between Pemberton and Vincentown, Burlington County, N. J.
5. Near Vincentown, Burlington County, N. J. From a heap already dug.
6. Near Vincentown, Burlington County, N. J.
7. One and one-half miles northeast of Pemberton, Burlington County, N. J. From a recent stock pile.
8. One and one-half miles northeast of Pemberton, Burlington County, N. J.
9. North of Birmingham, Burlington County, N. J.
10. Two miles southwest of Mullica Hill, Gloucester County, N. J.
11. West of Sewell, on Chestnut Branch, Gloucester County, N. J.
12. Southwest of Laurel Springs, Camden County, N. J.
13. From an old heap on the Chesapeake & Delaware Canal near Delaware City, Del.

It is of interest to compare these analyses of greensands with those published in an early report [3] of the State geologist of New Jersey.

[1] Lewis, J. V., and Kümmel, H. B., Geologic map of New Jersey: New Jersey Geol. Survey, 1910–1912.
[2] Lewis, J. V., and Kümmel, H. B., The geology of New Jersey: New Jersey Geol. Survey Bull. 14, pp. 63–69, 1915.
[3] Clarke, W. B., New Jersey Geol. Survey Ann. Rept. for 1892, pp. 230–231, 1893.

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Potash in greensand (marls) in Monmouth and Middlesex counties, N. J.

No.	Percentage of potash (K_2O.)	No.	Percentage of potash (K_2O.)
1	1.54	8	4.47
2	3.79	9	3.10
3	5.27	10	7.08
4	3.65	11	5.29
5	3.82	12	3.97
6	6.46	13	4.98
7	3.78		

1. Clay marl from point near Mattawan.
2. Clay marl from Matchaponix Creek, 3 miles south of Spottswood.
3. Lower marl from Navesink Highlands.
4. Lower marl from north shore of Navesink River, at Red Bank.
5. Lower marl from Hop Brook, near Marlboro.
6. Lower marl from northwest slope of Mount Pleasant hills.
7. Lower marl from point north of Freehold.
8. Lower marl from indurated layer at Tinton Falls.
9.
10. Middle marl from point near Eatontown.
11. Middle marl from point southeast of Freehold.
12. Upper marl (Manasquan) from Poplar.
13. Upper marl (Shark River) from Shark River.

Besides glauconite the greensand contains variable quantities of finely divided iron oxide, clay, and silt, which are lighter than the glauconite itself; also large particles of quartz and other minerals that contain no potassium. These larger particles may be removed by passing the material through a 40-mesh or preferably a 20-mesh sieve, so that the particles that are lighter than the glauconite may be washed or floated away. By this and other mechanical processes the glauconite in these greensands, and hence the content of potash, may be increased.

Nearly all the samples of greensand collected by the Survey were taken from deposits that lie near lines of transportation. The greensand deposits of New Jersey and the neighboring States are close to railroads and to navigable water and can be easily and cheaply worked, for their overburden is in few places great. Even without treatment they are a valuable fertilizer. In the voluminous discussion of sources of potash salts in the United States the greensands of New Jersey and near-by States seem to have been overlooked, but their composition and occurrence should commend them to the attention of those who are experimenting with the silicates as a source of soluble potassium salts.

H. P. Bassett,[1] of Catonsville, Md., has described a process of obtaining potassium salts from greensand that consists chiefly of glauconite. Bassett has found that the potassium content of greensand can be made soluble in water by heating the material to a reacting temperature with sodium acid sulphate and sodium chloride, the reaction being carried out preferably in the presence of reducing agents, such as coke, which should be present in such quantity as to reduce only part of the sulphate. The proportions in which the substances are to be used are given.

[1] U. S. patent 1159464, dated Nov. 9, 1915.

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COPPER AND GOLD ORE TAILINGS.

Attention has been called by the United States Geological Survey [1] to the fact that potash occurs in the tailings that are produced in immense quantity at copper and gold concentration plants in certain western mining districts. Some masses of these tailings contain a percentage of potash high enough to make them of commercial interest, provided a process can be devised for its profitable extraction. The tailings are already in a finely divided form and are generally well located with respect to cheap transportation and to cheap supplies of electric and water power.

The tailings themselves would probably never bear the cost of transportation for their content of potash, for most of the masses contain no more potash than the abundant and accessible deposits of greensand in New Jersey and possibly other Eastern States; but as raw material already available and in convenient form for local potash salts industries they deserve the careful attention of chemical and mining engineers.

RECENT PROCESSES FOR EXTRACTING POTASH SALTS FROM SILICATE ROCKS.

M. F. Coolbaugh and E. H. Quinney,[2] of Rapid City, S. Dak., describe a process for producing potassium and aluminum sulphates.

Feldspar, leucite, or other rock is first crushed to pass through an 80-mesh sieve and then mixed with similarly pulverized gypsum or limestone in proportions that have been carefully determined. The mixture is heated to incipient fusion, cooled quickly, and crushed. It is then leached with water containing sulphuric acid, the quantity of which is regulated by the amount of potash and alumina present. After leaching, the potassium sulphate and the aluminum sulphate are separated from the solution by crystallization. The yield is 90 to 92 per cent of potash and 93 to 98 per cent of the alumina contained in the rock treated.

Samuel Peacock [3] describes a process of decomposing alkali-metal-silicates as follows:

A potash-bearing silicate, like feldspar, is mixed with ground coke, coal dust, or finely divided carbon, and is heated to about 1,500° to 1,600° C. in an atmosphere containing nitrogen, but substantially no oxygen, and the potassium, sodium, and aluminum are largely separated as volatile carbo-nitrides (K_2CN_2, Na_2CN_2, and $Al_2C_3N_6$). A pressure below that of the atmosphere facilitates decomposition and increases the proportion of the volatile to the solid products.

The carbo-nitrides obtained may be condensed and treated with hot water, or they may be led directly into water. Decomposition takes place with evolution of ammonia, which can be recovered. The carbonates of sodium and potash and pure alumina are produced as indicated by the following reactions:

$$Na_2CN_2 + 3H_2O = Na_2CO_3 + 2NH_3$$
$$K_2CN_2 + 3H_2O = K_2CO_3 + 2NH_3$$
$$Al_2C_3N_6 + 9H_2O = Al_2O_3 + 3CO_2 + 6NH_3$$

[1] Butler, B. S., Potash in certain copper and gold ores: U. S. Geol. Survey Bull. 620, pp. 227–235, 1915.
[2] U. S. patent 1125007, dated Jan. 12, 1915.
[3] U. S. patent 1134413, dated Apr. 6, 1915.

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This process may also be described as a process for the fixation of atmospheric nitrogen, the principle of which is explained in another patent by Samuel Peacock, namely, United States patent No. 1154800, dated September 28, 1915.

E. E. Dougherty [1] has devised a process for obtaining potash from leucite rocks. When leucite is treated with hydrochloric acid the potash and alumina it contains are extracted. The sandy siliceous residue that is left contains a small amount of potash and alumina, which can be easily recovered by washing. Hydrochloric acid, however, is expensive, and the potash and alumina can be extracted with sulphuric acid mixed with from 2 to 5 per cent of hydrochloric acid.

The leucite is finely ground and sulphuric acid is added in quantities sufficient to combine with the bases. Hydrochloric acid is then added in the proportion of 2 per cent by weight of the leucite. The mixture is then heated and stirred till it becomes pasty. The heat is increased until the remaining water goes off, next the hydrochloric acid, and then the excess of sulphuric acid. These acids may be recovered.

The baked mass is lixiviated with boiling water, whereupon the potash and alumina go into solution as sulphates and may be recovered by any suitable means. Common salt may be substituted for hydrochloric acid, and the quantity of sulphuric acid also should then be increased sufficiently to react with the salt.

S. E. Melkman [2] has patented a process for producing soluble potash salts from silicate rocks. It consists of mixing finely divided feldspar with common salt and carbon, also in finely divided form, and subjecting the mixture to the action of concentrated sulphuric acid at a temperature of about 200° C. The resulting product is then roasted in a suitable furnace in the presence of air, preferably at a temperature so low that the reaction will take place without fusion. The temperature, however, should be high enough to volatilize a small quantity of potash, as this insures maximum decomposition of the feldspar. Good results have been obtained at temperatures ranging from 1,000° to 1,150° C.

The resulting clinker may be ground and the potash salts dissolved in water. When the temperature has been high enough to volatilize potash salts, they may be recovered by any of the usual methods. The recovery of the hydrochloric acid produced during the first stage of the reaction lessens the cost of production.

C. W. Drury [3] has patented a process for treating silicate-bearing minerals like feldspar and leucite. The aim is not to obtain the potassium as chloride or sulphate, but to obtain a product which, though still a silicate or a mixture of silicates, is readily decomposed by dilute acids or even by acids of the soil.

The feldspar is heated with lime or limestone and iron oxide in a blast furnace. Carbon in the form of coke is added, which, while serving as the fuel, reduces the iron to the ferrous form, in which it enters the slag. The materials may be mixed together in lumps and the coke added before they are put into the furnace.

The resulting product is a siliceous slag which, when ground, may be used in fertilizers or may be further treated to obtain its potash. The product appears to be a mixture or solid solution of the silicates of iron, calcium, aluminum, and potassium, but, unlike the original

[1] U. S. patent 1148156, dated July 27, 1915.
[2] U. S. patent 1148850, dated Aug. 3, 1915.
[3] U. S. patent 1150815, dated Aug. 17, 1915.

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double silicate (feldspar), it is readily decomposed by a one-half per cent acid solution.

F. A. Rody,[1] as already noted (p. 116), has patented a process which is based on the discovery that, if oxides of the alkaline earth metals are mixed with silicates like feldspar and leucite in such proportion that for each molecule of silica the mixture will contain two molecules of the alkaline earth metal oxide, and if the mixture be next sintered, the reaction will yield a silicate of the alkaline earth metal and the alkali and alumina will be released in a condition in which they are readily soluble in water. From the aqueous solution they can both be recovered in substantially pure form.

Limestone and dolomite, either calcined or uncalcined, may be used as a source of the alkaline earth oxide. When these are not obtainable, calcium or magnesium chloride may be substituted. Calcium chloride has a certain advantage, for it may be recovered in solution at a later step in the process and its use produces a more intimate intermixture of the alkalies with the silicates.

A process described by F. A. Rody and H. M. Burkey[2] is an improvement or modification of that outlined in patent No. 1151533. It involves the reduction of at least half the quantity of reagent required to combine with the silicate. This result is accomplished by substituting an alkali, such as sodium carbonate, for part of the lime in the mixture. The two reagents are added in such quantity that there shall be two molecules of alkali for one molecule of alumina and one molecule of calcium oxide for each molecule of silica.

The mixture is sintered, crushed, boiled with water, and the alkali and alumina are separated as alkali aluminate by filtration or otherwise. This aluminate may then be recovered from the solution and a part of it used, either with or without additional sodium carbonate, for mixing with other crushed feldspar and leucite.

A proposal is made by A. C. Spencer and K. P. McElroy[3] to produce potassium cyanide or sodium cyanide by treating rocks of high alkali content in a blast furnace.

Raw materials indicated as suitable for this process are greensand, feldspar, leucite, basalt, nephelite, and syenite.

Perhaps the most interesting feature of this proposal is that it contemplates the fixation of atmospheric nitrogen on a large scale without the use of electrical energy.

A. C. Spencer[4] proposes to recover potassium compounds from feldspar, leucite, basalt, or other potash-bearing rocks by volatilization. A by-product of building bricks made from the hot plastic clinker is contemplated.

In this specification reference is made to a patent application describing the simultaneous production of Portland cement and potash fume from feldspar and feldspathic rocks.

A. W. Heyman[5] has outlined improvements in processes for the simultaneous production of soluble alkaline hydroxides, namely, those of potassium and sodium, and cement making materials, from such siliceous or argillaceous products as feldspar, granite, slate, mica, shale, clay, cement rock or argillaceous limestone used in making cement, and similar substances.

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[1] U. S. patent 1151533, dated Aug. 24, 1915.
[2] U. S. patent 1151496, dated Aug. 24, 1915.
[3] U. S. patent 1156108, dated Oct. 12, 1915.
[4] U. S. patent 1157437, dated Oct. 19, 1915.
[5] U. S. patents 1160171 and 1160172, dated Nov. 16, 1915.

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The material is ground to a fine powder and intimately mixed with finely ground limestone, gypsum, marl, or other calcareous material. The quantity of calcareous material added depends largely on the chemical composition of the material treated; if the mixture already contains sufficient calcareous material no more is added, and the preliminary grinding and mixing may be omitted.

The mixture, either natural or artificial, is next heated in a suitable kiln or furnace to a red heat or higher, preferably to a temperature between 900 and 1,600° C. The hot material may be plunged into water or it may be allowed to cool and then, either ground or unground, placed in water. By this treatment the hydroxides of potassium and sodium are extracted. The solution is then evaporated with or without the conversion of the hydroxide into the carbonate, sulphate, chloride, nitrate, or any other desired salt.

The residue remaining from the extraction may be dried and ground as an alkali-free Portland cement, provided its content of calcium oxide bears proper relation to that of the argillaceous material. If this relation is not correct it must be made so by the addition of the proper quantity of the material that is lacking.

BY-PRODUCT POTASH IN THE CEMENT INDUSTRY.

Potash was first produced from cement dust by the Cottrell process (invented by F. G. Cottrell, chief metallurgist of the Bureau of Mines) by the Western Precipitation Co. at the plant of the Riverside Portland Cement Co., near Riverside, Cal. The experimental plant was not installed to obtain potash salts but to mitigate the dust nuisance, which had caused the company both expense and annoyance. In that plant, however, the precipitation of the dust by electricity in the manufacture of cement has proved to be a practical and commercial method of obtaining potash.

The raw mixture used by the Riverside company contains a feldspar having a small content of potash. In burning this mixture the potash is volatilized, caught, and concentrated in the precipitation of the dust. When the Riverside plant is working at full capacity one special kiln is used for reburning the accumulated dust, which is first mixed with sufficient raw material to balance the feed. In this special kiln the potash is further concentrated.

Analyses made by the Western Precipitation Co. show that the proportion of potash in many raw mixtures used at different cement plants throughout the country is larger than in the mixture at Riverside. The manufacture of by-product potash not only yields a considerable revenue, but the flue dust is saved and converted into cement and the dust nuisance is thereby eliminated.

The potash recovery plant at Riverside, Cal., which has been in operation since January, 1913, was noticed in Mineral Resources for 1912. Since the precipitation process was installed at Riverside about a million cubic feet of gas a minute has been treated, thus preventing the discharge of a hundred tons of dust a day over the surrounding orange groves,[1] besides producing a revenue from the potash recovered.

[1] The Cottrell process and its applications are discussed in Smithsonian Inst. Ann. Rept., 1913, pp. 653-685. See also abstract of a recent paper by F. G. Cottrell, entitled "Recent progress in electrical smoke precipitation," presented before Section VII, subsection 2, Second Pan American Scientific Congress, Washington, D. C., Jan. 4, 1916.

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It is understood that appliances for recovering by-product potash in connection with the manufacture of cement are being installed at the plants of the Security Cement & Lime Co., at Security, near Hagerstown, Md., and the Universal Portland Cement Co., Duluth, Minn., and also at a special plant in Buffalo, N. Y.

The problem of obtaining potash salts from the dust and gases formed at cement kilns and possibly also from those formed at iron blast furnaces is now interesting because of the high price of potash salts. When these two fields have been thoroughly investigated the experiments may be extended to copper and lead smelting, but those industries may wait until the others have been thoroughly covered. The possibility of obtaining potash salts as a by-product in connection with leaching processes in metallurgy is also interesting and this may prove to be a field for fruitful research.

S. B. Newberry,[1] of Baybridge, Ohio, has outlined a process for recovering alkali from cement kilns. According to the patent, the quantity of alkalies contained in cement clinker under given conditions of burning is practically constant and is not increased by increasing the proportion of alkalies in the raw mixture. The quantity of alkalies remaining in the clinker may be reduced to a minute percentage by increasing the temperature and the time of exposure to high heat beyond the temperature and time ordinarily employed.

Only a very small part of the alkalies volatilized in the kiln is deposited with the flue dust and this is chiefly in a form insoluble in water. The remaining alkali may be almost completely recovered from the stack gases by bringing them into intimate contact with sprays of water or by passing the gases through a space fitted with porous material, the surfaces of which are kept wet with water. In this way there is obtained a solution containing the smaller part of the alkali in soluble form and an insoluble sediment or mud containing the larger part of the alkali in insoluble form. If the insoluble matter is separated from the solution by filtering or subsidence and is returned to the kiln with the fresh raw material, the percentage of alkali in that material is thereby increased. As the alkali in the clinker remains practically constant it follows that an increased amount of alkali is volatilized and that a stronger solution and a mud richer in alkali are obtained.

The proportion of soluble to insoluble alkali recovered remains practically the same, and consequently by continually returning to the kiln the flue dust and mud containing insoluble alkali a progressively increasing quantity of soluble alkali is recovered, until an amount of soluble alkali practically equal to the total alkali content in the raw mixture is regularly obtained.

Newberry illustrates his process with figures and also describes important results of his experiments and devices, which he has found of great advantage in recovering the maximum quantity of alkalies from the raw materials used in making cement.

An invention of Samuel Peacock[2] relates to a process of obtaining potash salts from flue dust. According to Peacock, in the ordinary processes of furnacing raw mixtures in the manufacture of Portland cement, 50 to 75 per cent of the potassium contained in the furnace charge is volatilized and passes out of the kiln with the flue dust.

[1] U. S. patent 1150295, dated Aug. 17, 1915.

[2] U. S. patent 1124798, dated Jan. 12, 1915.

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Furthermore, of the total potassium found in the dust 40 to 60 per cent is usually combined as a basic silicate, which is insoluble in water.

In the process patented the flue dust is treated with water to extract any soluble potash salts. To recover the potash from its insoluble silicate combinations a solution containing monocalcium phosphate is employed, for it has been found that when potassium silicate is finely ground and treated or digested with a hot solution containing monocalcium phosphate a reaction occurs yielding potassium phosphate and calcium silicate. Peacock has also found that when calcium silicate, which contains a potassium salt, is finely ground and digested with sulphuric acid the potassium is recovered in the form of the soluble salt of the acid used.

The proposal is made by A. C. Spencer [1] to recover potash products from natural cement rock.

The magnesian cement rocks referred to are those formerly used for making natural cement in various Eastern States and in Ohio, Illinois, and Wisconsin. No general study of the potassium content of these cement rocks has been made, but data at hand indicate that they may carry from 1.5 to perhaps 3 per cent potash (K_2O).

KELP.

PLANTS IN OPERATION.

A few firms appear to have seriously undertaken the production of potash salts from kelp, and the outlook seems favorable for the establishment of such an industry. At least three companies are at work on plants in which kelp will be treated. Two of them, the American Products Co., Long Beach, Cal., and the Hercules Powder Co., of Wilmington, Del., with works at Chula Vista, Cal., are utilizing kelp for other products than potash salts and their intention is to market the potash as a by-product. One of these firms will handle about 500 tons of wet kelp a day and the other approximately 1,000 tons. Harvesters have been constructed for cutting the kelp, which have been tried out and found to work satisfactorily. Another company, the Swift Fertilizer Co., with headquarters at San Diego, Cal., will treat kelp primarily for the extraction of potash salts. The Pacific Potash Co., of Seattle, Wash., reported to the Survey late in 1915 that it expected to have "a product of dried kelp" ready for market early in 1916. In addition to these firms, several small companies have been formed to produce potash salts from kelp along the Washington and southern California coast. Their operations are not now of importance.

PROCESSES FOR TREATING KELP.

Carl Klingbiel [2] has patented a process for making potassium and sodium salts from kelp ashes. Previous methods are claimed to have many defects, which are pointed out. It was found that the addition of phosphoric acid in excess to the saturated liquors of the ashes greatly simplified and improved the separation of potassium and sodium salts, as well as the extraction of iodine. Excess of the acid decomposes the carbonates, sulphides, sulphites, and thiosulphates. Excess acid is

[1] U. S. patent 1146532, dated July 13, 1915. [2] U. S. patent 1162617, dated Nov. 30, 1915.

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neutralized by adding a suitable alkali. The sulphuric acid present is removed in the form of sodium sulphate.

When the neutral liquor is boiled down, the potassium salts crystallize out on cooling and the sodium salts are removed from the hot solution. The final liquor, very rich in iodine and of small volume, may be treated with chlorine for the removal of the iodine. The mother liquor, colored brown with the latter, still carries some potash. To save this and the iodine, the mother liquor and the wash water are used to dissolve fresh lots of kelp ashes, by which method the iodine is at once fixed by the sulphides and sulphates in them.

This process is claimed to allow no loss of potassium. The sodium salts are obtained quantitatively and free from alkali-metal-carbonate and may be used for any suitable purpose. The separation of sodium and potassium salts is easily accomplished, as compared with other methods. The phosphoric acid is combined with potassium and the resulting potassium phosphate has a considerable value as fertilizer.

S. R. Oppenheim [1] has patented a process for producing charred kelp. In the furnaces described a down draft is used and one or more injector burners adapted to project the flame directly upon the surface of the kelp are provided. Drawings are given to illustrate the pattern of the furnace preferred and the method of manipulation is also explained.

According to the patent, a 1,000-pound charge of kelp may be reduced to a charred condition in from 45 minutes to 1 hour, in contrast with older methods, according to which as much as 48 hours may be required. Three gallons of oil are needed for fuel, compared with 30 gallons for the same charge by older methods.

One of the objects sought is to reduce the charge in such a manner as to prevent waste of the potash or other salts. To accomplish this an average temperature of about 350° C. is kept within the furnace; therefore no decomposition or volatilization takes place and the change to carbonates is avoided. Still another object is so to treat the kelp as to leave the residue after leaching in such a condition that it may be used for a variety of purposes. This residue consists of pure vegetable carbon, which may be used for (1) filtering and deodorizing; (2) medicinal purposes; (3) carbon for arc lamps; (4) paints and inks; and (5) on soils. The old methods left a residue consisting chiefly of ashes and clinker; the residue from Oppenheim's process is said to be valued at $10 a ton.

MISCELLANEOUS SOURCES OF POTASH SALTS.[2]

Miscellaneous sources of potash salts have been much discussed during 1915, most of them being organic sources like molasses residues, the residues from grape fermentation (argols), excreta from animals, wool scourings (suint), municipal wastes, the ashes from sea grasses, and especially the ashes from mesquite, and sage brush, so common in parts of our Western States.

The latter source of soluble potash salts attracted considerable attention during the early part of 1916. A sample of the ashes from Parowan, Utah, was examined by the Survey and found to represent 2.97 per cent of the original wood. It contained 21.06 potash (K_2O).

[1] U. S. patent 1141482, dated June 1, 1915.

[2] Some of these miscellaneous sources of potash salts were described at length in the reports on potash for 1910 and 1911.

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Other samples of ash have been reported to run more than 30 per cent in potash, and from this high figure the content ranges to a very low one. Care in burning the wood has to be exercised, for unless this is done more or less of the potash may form insoluble compounds with silica. The lower the quantity of soluble potash the less the demand there is for the ash and the less the probability of its being able to stand the high freight rates to points in the Eastern States, where the greatest demand exists.

S. W. Sinsheimer[1] has invented a process for the recovery of the concentrated product containing nitrogen and potash from the waste liquors resulting from the separation of sugar from molasses obtained from sugar beets.

In the commercial process for making sugar from sugar beets there results a waste liquor containing considerable quantities of lime, potash salts, and nitrogen. Owing to the presence of much water and scale-forming substances, this liquor has heretofore not been used, and it is the object of this invention to save it and make use of it as fertilizer.

The liquor is first heated and such solids as are precipitated are filtered off and the solution is then treated with carbon dioxide gas. The insoluble carbonates which form are removed by filtration and the solution then goes to a multiple-effect evaporator. The mass delivered from the last effect is dried at a low temperature to prevent loss of nitrogen compounds. The dried product contains 3 to 5 per cent nitrogen and 12 to 25 per cent potash, reckoned as oxide. If the filtrate from the insoluble carbonates is treated with sulphuric acid, the potash remaining in the dried mass is in the form of the sulphate.

FOREIGN DEPOSITS OF POTASH SALTS.

SPAIN.[2]

During recent years interest has been directed to the potash deposits in the provinces of Barcelona and Lerida, in the northeastern part of Spain. Borings and analyses have been made with favorable results. In various borings near the town of Sarria, potash salts were found at depths between 121 and 197 feet, and also at a depth of 426 feet. At a depth of 886 feet, the greatest attained, potassium salts were found resting on a bed of white salt which was not pierced. In the area tested by borings, which comprised between 61 and 62 acres, there is an estimated quantity of 2,550,000 tons of carnallite and 1,150,000 tons of sylvite.

From the general character of the region it is considered probable that other deposits of potash salts will be found close to those already discovered. A considerable percentage of potash salts has been found in the waters of the stream running by the salt works at Cardona, and it has been further discovered that large quantities of potash salts have been allowed to go to waste in these mines which might have been used.

The complex character of the geology in the region near Barcelona renders it difficult to make close quantitative estimates of the potash

[1] U. S. patent 1134921, dated April 6, 1915.
[2] Hurst, C. B., U. S. Consul General, Barcelona, Spain, supplement to Commerce Reports No. 15c, July 10, 1915.

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salts available. The presence of gypsum beds and the potash-bearing stream waters, however, should serve as guides in locating new deposits or continuations of those already known.

Interest has been displayed in these salts by certain firms in the United States, and at least one American company has secured concessions from the Spanish Government. In view of the national importance of the deposits, the Spanish Government is taking measures for supervising them, if not for exploiting them. Because of the small quantity of potash salts available for use in Spain, their export is forbidden for the time being.

When the potential supplies in the ground near Barcelona appear on the market there should be a considerable quantity for export in excess of the Spanish requirements. Though the consumption is small in Spain compared with the United States, it is increasing, especially as a fertilizer.

CHILE.[1]

Potash salts were discovered many years ago in Chile, but for some reason they have attracted little attention. They occur in Pintados and Bella Vista lakes, in the province of Tarapacá, not more than 3 miles from the railroad that runs from Iquique to Lagunas. The potash occurs over an area of 10,000 acres as the chloride in a saline crust and samples have been found containing from 3 to 36 per cent. The crust is not very thick (about 8 inches) and has been formed by the evaporation of an underlying bittern. A calculation has been made that the salt beds contain more than 2,000,000 tons of potassium chloride. The absence of magnesium salts, bromides, and iodides is noteworthy.

NITRATES.

Many reports of occurrences of nitrate that have come to hand during the year have been collected by Hoyt S. Gale, and some of the deposits have been examined by members of the United States Geological Survey. Most of them seem to be of the same type and of very doubtful commercial value. There are reports of deposits in Sulphur Spring Valley, Cochise County, and in Yavapai County, Ariz.; of cave earths high in nitrates in Madison County and Searcy County, Ark.; of deposits in Modoc County, San Diego County, and elsewhere in California; of a cave deposit containing nitrates in Oregon County, Mo.; of deposits in ledges in southern Nye County, in southeastern Churchill County, and in Humboldt County, Nev.; of deposits near Rodeo and Pratt (Grant County), about 60 miles "above" El Paso, in the foothills of the Guadalupe Mountains some 40 miles from Carlsbad, and about 18 miles north of Deming "up toward Cook's Peak," in New Mexico; of numerous deposits and considerable interest in locating claims about Burns and south of Riley in Harney County, at several places in Lake County, and also at localities in Malheur County, Oreg.; of deposits in Texas near Van Horn, San Saba, Presidio; and in Utah near Tucker and Thistle.

The nitrate deposits near Homedale, Idaho, were discovered in the spring of 1914 and in the fall of the same year they were examined by G. R. Mansfield, of the United States Geological Survey. They

[1] Salcedo, S., Eng. and Min. Jour., vol. 100, p. 218, Aug. 7, 1915.

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are located in and near the canyon of Sucker Creek, in Oregon, about 16 miles in a direct line southwest of Homedale, Idaho, and 26 miles by road, and also in the valley of Jump Creek, Idaho, 10 miles east of the occurrence on Sucker Creek.

Nitrate has been received by the Survey from the vicinity of Soldier, Blaine County, Idaho. The occurrence at Soldier has not been examined, but a study of the samples received suggests that the mode of occurrence is the same as at Homedale.

The nitrate occurs in rhyolite in veinlets, which also carry other salts. The saline matter does not constitute more than 1 per cent of the rock. How far the small veins extend into the rock can not be stated, but there seems to be little likelihood of any increase in richness with depth. According to Mansfield,[1]

> The Homedale and Soldier deposits may be taken as types of material from localities in many parts of the country, ranging all the way from Oregon to Texas, from which specimens have lately been received by the Geological Survey. The niter occurs on the surface and in cracks, forming in places rich veins in considerable quantity, but at no place yet examined has this superficial material seemed to lead to deposits extensive enough to have commercial value. Investigations should be continued in the hope that a commercially valuable deposit may be found. At the present time, however, the outlook is not very promising.

EXPLANATION OF THE TERM "POTASH."

To meet the numerous inquiries that have been addressed to the United States Geological Survey regarding the exact meaning of the terms "potash," "actual potash," and "potassium," the following explanation is given:

The element potassium, represented by the symbol K, is the basis of all potash salts or compounds. This substance is a metal; that is, it possesses metallic properties. To prevent rapid change it must be kept from air and water, with both of which it combines with great avidity. Combined with oxygen it forms potassium oxide, represented by the symbol K_2O, known as potassa, but popularly as "potash." In estimating the quantity of potassium in the different products of the Stassfurt deposits, this compound, K_2O, is employed as a standard, the object being to establish a basis of comparison for all potassium salts. Among chemists as well as laymen there has grown up the practice of using for this standard the term "potash." When only the term "potash" is used in speaking of potash products, it is understood to refer to the potassium oxide (K_2O) present. As a matter of fact, however, potash salts are not sold in the form K_2O, but as the sulphate or the chloride. By the term "potassium sulphate" is meant potassium (K) combined with the acid radicle of sulphuric acid (SO_4), or potassium oxide (K_2O) combined with sulphur trioxide (SO_3), making the compound K_2SO_4. By "potassium chloride" is meant potassium (K) combined with another element, chlorine (Cl), and represented by the formula KCl.

In the following table are given the percentages of the element potassium and also of the combination known as potash in or obtainable from the common potassium compounds and minerals:

[1] Nitrate deposits in southern Idaho and eastern Oregon: U. S. Geol. Survey Bull. 620, p. 32, 1915 (Bull 620-B).

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Potassium and "potash" in potassium compounds.

Name.	Symbol.	Percentage of potassium (K).	Chemical equivalent in terms of "potash" (K_2O).
Element:			
Potassium	K	100	120
Potassium salts or "potash salts":			
Potassium chloride (mineral sylvite)	KCl	52	63
Potassium muriate (same as chloride).			
Potassium sulphate	K_2SO_4	45	54
Potassium nitrate (saltpeter)	KNO_3	39	47
Potassium carbonate [a]	K_2CO_3	57	68
Potassium hydrate or caustic potash	KOH	70	84
Potassium cyanide	KCN	60	72
Stassfurt minerals:			
Carnallite	$KMgCl_3.6H_2O$	14	17
Kainite	$MgSO_4.KCl.3H_2O$	16	19
Sylvite (potassium chloride)	KCl	52	63

[a] The term "potash" is often applied to this compound.

SIMPLE TESTS FOR POTASH.

By W. B. Hicks.

DETECTION.

Principles.—Potassium is generally found in nature in solution, as soluble salts or saline residues, in organic substances, in alunite, and in silicate rocks and minerals. Simple methods for detecting and determining it are here described for the benefit of those who may be interested in making rough field tests. These tests have been used with good results by members of the United States Geological Survey and may be used successfully, it is believed, by any one with little or no experience in chemical manipulation. They depend on the fact that when a volatile potassium compound is heated in a flame it imparts a characteristic violet color to the flame. Though usually masked by the colors produced by other elements, especially sodium and calcium, the coloration due to potassium is readily seen and identified by observing the flame through a Merwin color screen.

Equipment.[1]—The equipment necessary for making the tests herein described consists of—

1. Lamp for volatilizing the potash compound. For this purpose an ordinary alcohol lamp with an asbestos wick will often suffice, but a gasoline or alcohol blast lamp, which requires no wick and which burns with a hot, nonluminous flame, gives far better results.
2. Platinum wire about 4 inches long. One end of the wire should be sealed into the end of a short glass rod to serve as a handle, and the opposite end should be bent into the form of a small loop.
3. Merwin color screen.[2]
4. Small beaker.
5. Hydrochloric acid.
6. Gypsum or calcium sulphate.

Procedure for waters and brines.—First clean the loop of platinum wire by dipping it in hydrochloric acid and igniting it until the flame

[1] The equipment here described, except the Merwin color screen, may be purchased very reasonably from most dealers in chemical and laboratory supplies.

[2] The Merwin color screen is manufactured and sold by G. M. Flint, 84 Wendell Street, Cambridge, Mass., for 25 cents. Hand spectroscopes may be used instead of the Merwin color screen. These may be had from most dealers in laboratory apparatus at $7 or more.

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is no longer colored. By means of the clean platinum loop remove a drop of the solution to be tested, carefully evaporate it to dryness by holding over the flame, finally ignite, and observe the color of the flame through the Merwin color screen. The best results are obtained by using a black background, holding the Merwin screen close up against the eyes, and looking through the central section of the screen. If potassium salts are present, the flame will appear reddish to reddish violet, and the intensity and duration of the color will give some idea as to the amount of potassium.

Procedure for soluble salts.—For detecting potassium in saline residues and soluble salts in general, as well as for detecting soluble potassium compounds in muds, clays, and ashes, proceed as follows: Dissolve a portion of the sample in a small quantity of water, allow the undissolved material to settle out, remove a drop of the clear solution by means of the loop of platinum wire, and test in the flame as just described for waters and brines.

In tests for alum and other sulphates the clear solution should be poured off from the insoluble residue and some hydrochloric acid added before making the test.

The water used in all such tests should be examined to see whether it contains potassium.

Procedure for organic substances.—The substance to be tested is first ignited or burned at as low a temperature as possible until only the ash remains. The ash is then tested for potassium according to the procedure just described for soluble salts.

Procedure for alunite.—Powder the sample to be tested and moisten it with hydrochloric acid. By means of the loop of platinum wire transfer a portion of the moistened powder to the flame, ignite, and and observe the color of the flame through the Merwin color screen. If potassium is present, the flame will appear deep reddish violet.

Emphasis should be placed on the fact that this procedure is a test for potassium and not necessarily for alunite. Other potash-bearing materials, especially leucite and glauconite, will give similar results with such treatment.

The following simple field test for the mineral alunite has been suggested by W. T. Schaller:[1] Boil the powdered sample with water or with hydrochloric acid for several minutes; after allowing the powder to settle, pour off the liquid and repeat the operation to insure the removal of all soluble sulphates. Dry the powder and heat to dull redness. Again boil in water and, after settling, pour off some of the clear liquid. To this add a small fragment or a solution of barium chloride. If the mineral is alunite a heavy white precipitate will form. To be sure that the water used in this test does not contain sulphate in solution, it should be tested with barium chloride, and if it gives a marked precipitate it can not be used.

For this test all that is required that was not included in the equipment for the detection of potassium is a little barium chloride, a small crucible in which to ignite the mineral, and a support for the crucible.

Procedure for silicate rocks and minerals.—In order to detect potassium in silicate rocks and minerals, such as feldspar, granite, leucite, rhyolite, glauconite, and sericite, powder the material finely, mix with an equal quantity of pure gypsum, and moisten the mix-

[1] U. S. Geol. Survey Bull. 511, p. 63, 1912.

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ture with dilute hydrochloric acid. By means of the loop of platinum wire, transfer a portion of the moist mixture to the flame, ignite, and observe the color of the flame through the Merwin color screen. The reddish violet color will be apparent if potassium is present.

Although with less satisfactory results, as a rule, the test may be carried out by mixing the material to be tested with either hydrochloric acid or gypsum alone.

ESTIMATION.[1]

Equipment.—A rough quantitative determination of the soluble potash in any salt may be made according to the method described below. To obtain even approximately correct results the conditions in making up the standard and in carrying out the actual determination on the unknown salt must be exactly the same.

The extra equipment required for this work is a small balance and a measuring cylinder. A hand spectroscope in place of the Merwin color screen will probably give better results.

Standardization.—Dissolve 1 gram of pure potassium chloride in 10 cubic centimeters of water and mix thoroughly. Remove a drop of the solution by means of a loop of platinum wire, dry carefully over the flame, ignite, and examine through the Merwin color screen. Gradually dilute the solution with measured amounts of pure water, mixing thoroughly and testing in the flame for potash the resultant solution after each addition of water, until the potassium flame can just be seen or disappears altogether. Record the exact volume of the solution at this point, and by repeated trials make sure of the correctness of the value. Designate this value for the standard solution by S.

Determination.—Dissolve 1 gram of the salt to be tested in 10 cubic centimeters of water and mix thoroughly. Remove a drop of the solution by means of a loop of platinum wire, dry carefully over the flame, ignite, and examine the color of the flame through a Merwin color screen. Now gradually dilute the solution with measured amounts of water, mixing thoroughly and testing in the flame the resultant solution after each addition of water, until the potassium flame can just be seen or disappears altogether. Record the exact volume of the solution at this point, and by repeated trials make sure of the correctness of the value. Designate this value for the unknown salt by X.

Calculations.—To obtain the percentage of potash expressed as potassium chloride in the unknown salt, divide the volume of the unknown solution at which the potassium flame could no longer be seen, designated X, by the volume of the standard solution at which the potassium flame could no longer be seen, designated S, and multiply the result by 100. In other words,

$$\text{Percentage of potassium chloride (KCl)} = \frac{\text{Volume found for unknown salt}}{\text{Volume found for standard salt}} \times 100 = \frac{100X}{S}$$

$$\text{Percentage of potash } (K_2O) = \frac{63.17X}{S}$$

$$\text{Percentage of potassium (K)} = \frac{52.44X}{S}$$

[1] For a description and bibliography of spectroscopic methods for the estimation of potassium, see Skinner, W. W., and Collins, W. D., U. S. Dept. Agr. Bur. Chem. Bull. 153.

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ASPHALT.

By JOHN D. NORTHROP.

INTRODUCTION.

In a broad sense the term natural asphalt may be used to denote all types of naturally occurring asphaltic substances that are employed in the arts and industries. It is so used in this chapter in reference to the asphaltic materials commercially mined or quarried in the United States. They comprise the native bitumens maltha, grahamite, and gilsonite; the so-called "pyrobitumen" elaterite; the bitumen impregnated rocks, sandstone, limestone, and shale; and the cerous hydrocarbon, ozokerite. The term "manufactured asphalt," as used in this chapter, includes both oil asphalt, a solid or semisolid by-product obtained in the distillation of asphaltic and semiasphaltic petroleum, and residual asphaltic oils or pitches, the viscous residues of the evaporation or distillation of petroleum of asphalt base to a point where all the burning oils and often some of the heavier distillates have been removed.

OCCURRENCE AND DISTRIBUTION.

The natural asphalts occur in the United States in three principal forms—(1) as viscous, semiliquid substances filling interstices and cavities in rock of almost every type, but found most abundantly in sand, sandstone, and limestone; (2) as viscous and semisolid tenaceous exudations from the earth, either directly from exposed bituminous rocks or from subterranean passages; (3) as solids in the form of veins or irregular bodies, cutting across or lying between layers or masses of rocks. Stratigraphically, the natural asphalts here considered occur in commercial quantities in or associated with sedimentary rocks of all ages from Ordovician to Pleistocene.

The distribution of the natural asphalts in the United States is wide, deposits having been found at numerous localities in fully a dozen States, though commercial production is now limited to only a few localities in California, Colorado, Kentucky, Texas, Oklahoma, and Utah.

The manufactured asphalt produced in the United States is obtained from certain grades of crude petroleum found in California, Texas, Louisiana, Oklahoma, Kansas, and Illinois, as well as from the heavier grades of Mexican crude, which are imported in ever increasing quantities for the manufacture of asphalt and asphalt products.

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GENERAL CONDITIONS.

The use of asphalt in the United States is steadily increasing, but the trend of the increase is toward a greater utilization of asphalt manufactured from crude petroleum rather than toward a more extensive development of the deposits of naturally occurring asphaltic materials. The factors that are bringing about this change in the asphalt industry are chiefly economic in their nature, now that the experimental stage in the utilization of the artificial product has been passed. The cost at which large refineries at tidewater or at interior points adjacent to the sources of asphaltic oil can supply an

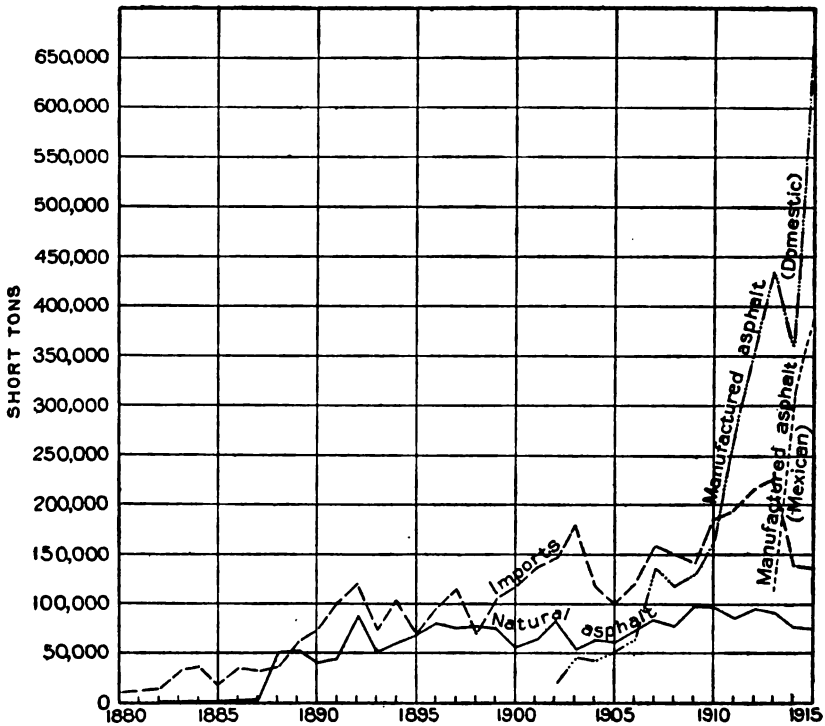

FIGURE 7.—Graphs showing marketed production of natural asphalt (all varieties) and of manufactured asphalt obtained from domestic and from Mexican petroleum, and imports of crude asphalt, in the United States, 1880–1915.

efficient substitute for the natural asphalts practically at the points of consumption is so low that only natural material of the highest grade, favorably situated with regard to quarrying, mining, and transportation, or of such a character as to be in demand for special purposes, can successfully compete with the manufactured material. In certain localities remote from sources of asphaltic petroleum but adjacent to deposits of suitable material in the form of asphaltic sandstone or limestone the natural asphalt retains its precedence.

The purer forms of solid or semisolid bitumen, such as gilsonite and grahamite, that are extensively utilized in the varnish and rubber industries and in electrical insulation supply a demand that

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is fairly constant and a market that has not been seriously invaded by man-made substitutes.

The accompanying diagram shows in graphic form the trend of the asphalt industry in the United States since 1880 and brings out more clearly than statistical tables the influence of manufactured asphalt on the demand for asphaltic materials from natural sources.

An interesting development in the asphalt industry was undertaken in 1915 by a company in Chicago looking to the utilization of the deposits of bitumen-impregnated shales found in western Colorado. After pulverization of the bitumen-rich shale and appropriate treatment with a synthetic resin a dark-brown molding compound is obtained, which hardens on drying and is reported to be of unusual strength and toughness and to possess properties of resisting heat, acids, and electricity to such an extent as to recommend its use in the manufacture of battery jars, steam-pump valves, chemical apparatus, table tops, and other products in the manufacture of which hard rubber or molding compounds having a wood filler are now used.

MARKETED PRODUCTION.

NATURAL ASPHALT.

The natural asphalt of all varieties sold at the sources of production in the United States in 1915 aggregated 75,751 short tons, valued at $526,490, a decrease of 4,137 tons, or 5 per cent, in quantity and of $15,633, or 2 per cent, in value from the corresponding totals in 1914. An analysis of the 1915 total shows that the decrease noted lies wholly in the quantity of bituminous rock marketed during the year, which amounted to 44,329 short tons in 1915, as compared with 51,071 short tons in 1914. A further analysis shows this decrease to be chiefly in the output of bituminous sandstone from California, though a small proportion is chargeable to Utah. That the net decrease for the entire country is no greater than recorded is due to increased output of bituminous rock from Texas and Oklahoma. As bituminous rock is utilized almost exclusively for paving and comes more intimately in competition with manufactured asphalts than the purer forms of bitumen that supply a variety of markets, the annually decreasing output of this type of asphalt may be ascribed directly to the keeness of this competition.

The statistics of output of the native bitumens, gilsonite and grahamite, in 1915 record slight increases over the output in 1914 and indicate a sufficient expansion of the home markets to compensate largely for the loss of foreign customers as a consequence of the European war.

The following table shows the combined output of all types of natural asphalt entering the markets from mines and quarries in the United States since 1882:

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Natural asphalt (including ozokerite) and bituminous rock sold at mines, 1882–1915.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1882	3,000	$10,500	1894	60,570	$353,400	1905	62,898	$305,242
1883	3,000	10,500	1895	68,163	348,281	1906	73,062	674,934
1884	3,000	10,500	1896	80,503	577,563	1907	85,913	928,381
1885	3,000	10,500	1897	75,945	664,632	1908	78,565	517,485
1886	3,500	14,000	1898	76,337	675,649	1909	99,061	572,846
1887	4,000	16,000	1899	75,085	553,904	1910	98,893	854,234
1888	50,472	190,500	1900	54,389	415,958	1911	87,074	817,250
1889	51,760	174,037	1901	63,134	555,335	1912	95,166	865,225
1890	41,016	216,666	1902	84,632	461,799	1913	92,604	750,713
1891	45,079	249,264	1903	55,068	483,282	1914	79,888	642,123
1892	87,710	453,375	1904	64,167	420,701	1915	75,751	526,490
1893	47,779	372,232						

MANUFACTURED ASPHALT.

The sales in 1915 of manufactured asphalt obtained from petroleum of domestic origin as reported to the Geological Survey amounted, at the sources of production, to 664,503 short tons, valued at $4,715,583, an average of $7.10 a ton, an increase of 303,820 tons, or 84 per cent, in quantity and of $1,698,614, or 56 per cent, in market value, but a decrease of $1.26, or 15 per cent, in average price per ton, as compared with the output in 1914. The output in 1915 includes 417,859 short tons, valued at $2,392,576, an average price of $5.73 a ton, of asphaltic oil used either for road sprinkling to allay dust or as a flux for softening harder bitumens, and 246,644 short tons, valued at $2,323,007, an average price of $9.42 a ton, of residual pitches, having a penetration less than 100 and utilized chiefly for paving. These statistics disclose increases of 246,412 short tons, or 144 per cent, in the output of road oils and fluxes and of 57,236 short tons, or 30 per cent, in the output of residual pitches, as compared with the statistics for 1914, and indicate clearly the ability of domestic sources to supply the growing demand for asphaltic materials needed in pavement and highway improvement, in the paint and varnish industries, and in the manufacture of roofing compounds, building papers, and rubber substitutes.

The increase in output of manufactured asphalt produced in the United States in 1915 from petroleum imported from Mexico was appreciable, but was much less than the corresponding increase in the output of this product from domestic crudes. The quantity of manufactured asphalt derived from Mexican petroleum at refineries in the United States in 1915 was 388,318 short tons, valued at $3,730,436, an average price of $9.61 a ton, at the refineries. This quantity includes 174,854 short tons, valued at $1,325,201, an average price of $7.58 a ton, of material classed as road oil and flux, and 213,464 short tons, valued at $2,405,235, an average price of $11.27 a ton of material classed as residual pitch.

The corresponding quantities in 1914 were—total output, 313,787 short tons; road oil and flux, 111,058 tons; and residual pitch, 202,729 tons.

The number of plants supplying the output of manufactured asphalt in the United States in 1915 was 39, of which 28 utilized exclusively petroleum of domestic origin, 9 utilized exclusively

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petroleum of Mexican origin, and 2 utilized petroleum from both sources.

The succeeding tables show by years and by sources of crude petroleum used the marketed production of manufactured asphalt in the United States since this phase of the asphalt industry became important.

Manufactured asphalt from domestic petroleum sold at refineries, 1902–1915.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1902	20,826	$303,249	1907	137,948	$1,898,108	1912	354,344	$3,755,506
1903	46,187	522,164	1908	119,817	1,540,396	1913	436,586	4,531,657
1904	44,405	459,135	1909	129,594	1,565,427	1914	360,683	3,016,969
1905	52,369	452,911	1910	161,187	2,225,833	1915	664,503	4,715,583
1906	64,997	615,406	1911	277,192	3,173,859			

Manufactured asphalt from Mexican petroleum sold at refineries, 1913–1915.

Year.	Quantity (short tons).	Value.
1913	114,437	$1,743,749
1914	313,787	4,131,153
1915	388,318	3,730,436

PRODUCTION BY CLASSES AND BY STATES.

The following tables record by principal varieties the sales of asphaltic material at the sources of production in the United States and show the distribution by States of the output of the natural varieties during the last five years:

Asphalt sold at mines and refineries, 1911–1915, by varieties.

Variety.	1911		1912		1913	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Bituminous rock	[a] 42,654	[a] $159,670	[a] 54,762	[a] $173,018	57,549	$173,764
Maltha	8,574	125,966	474	3,518	.....	.....
Wurtzilite (elaterite)	610	30,500	[b] 8,452	[b] 115,620		
Gilsonite	30,236	496,114	31,478	573,069	35,055	576,949
Grahamite	5,000	15,000	(c)	(c)		
	87,074	817,250	95,166	865,225	92,604	750,713
Manufactured or oil asphalt [d]	277,192	3,173,859	354,344	3,755,506	436,586	4,531,657
	364,266	3,991,109	449,510	4,620,731	529,190	5,282,370

[a] Includes small output of mastic.
[b] Includes grahamite.
[c] Included in Wurtzilite.
[d] This item includes material derived from petroleum of domestic origin only.

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Asphalt sold at mines and refineries, 1911–1915, by varieties—Continued.

Variety.	1914		1915	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Bituminous rock	51,071	$162,622	44,329	$157,083
Maltha				
Wurtzilite (elaterite)	19,143	405,966	20,559	275,252
Gilsonite				
Grahamite	9,669	73,535	10,863	94,155
	79,888	642,123	75,751	526,490
Manufactured or oil asphalt [a]	360,683	3,016,969	664,503	4,715,583
	440,571	3,659,092	740,254	5,242,073

[a] This item includes material derived from petroleum of domestic origin only.

Natural asphalt sold at mines, 1911–1915, by States.

State.	1911		1912		1913	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
California	36,481	$220,580	36,741	$100,481	27,870	$69,825
Kentucky	(a)	(a)	[b] 10,145	[b] 46,032	[b] 17,465	[b] 60,131
Oklahoma	[c] 19,747	[c] 80,056	15,766	85,643	16,459	91,416
Texas			(d)	(d)	(d)	(d)
Utah	30,846	516,614	32,514	633,069	30,810	529,341
	87,074	817,250	95,166	865,225	92,604	750,713

State.	1914		1915	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
California	28,186	$77,810	17,794	$61,485
Kentucky	[b] 18,935	[b] 66,298	[b] 19,311	[b] 65,352
Oklahoma	9,669	73,535	16,907	118,351
Texas	(d)	(d)	(d)	(d)
Utah	23,098	424,480	[e] 21,739	[e] 281,302
	79,888	642,123	75,751	526,490

[a] Included in Oklahoma.
[b] Includes Texas.
[c] Includes Kentucky.
[d] Included in Kentucky.
[e] Includes Colorado.

CONDITIONS AND PRODUCTION IN THE PRINCIPAL PRODUCING STATES.

California.—The natural asphalt sold at the mines in California in 1915, which amounted to 17,794 short tons, valued at $3.46 a ton, consisted chiefly of bituminous sandstone from the well-known localities in Santa Cruz and San Luis Obispo counties. A small quantity of material classed as bituminous limestone was reported from Santa Cruz County. Compared with the annual yield in recent years this output shows a decrease that reflects strongly the influence of local competition by the manufactured product. The output of asphalt of the latter type in California was distributed in 1915 among 20 refineries and amounted to 238,917 short tons, valued at $1,516,979,

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or an average price of $6.35 a ton. Compared with the statistics for 1914 these figures show a decrease of 21,055 tons in quantity and of $1.55 in the average price per ton received for the manufactured asphalt marketed. The depressed condition of the crude petroleum market in California during the greater part of the year is believed to account largely for the lower price at which manufactured asphalt could be marketed in 1915 and, going a step further, also for the falling off in the local output of bituminous rock.

Of the output in 1915 of manufactured asphalt from California sources 78,200 short tons, valued at $309,147, or an average price of $3.95 a ton, were marketed for road oiling and fluxing, and 160,717 short tons, valued at $1,207,832, or an average of $7.52 a ton, comprised residual pitches marketed chiefly for pavement construction.

Colorado.—The return of Colorado to the ranks of asphalt-producing States was effected by the quarrying of a small quantity of bituminous shale in the western part of the State and its consumption in Chicago in experimental work, the nature of which is described on page 137 of this report. The outlook for a more extensive development of the deposits in 1916 is reported as encouraging.

Kentucky.—The contribution of Kentucky to the asphalt industry in 1915 consisted of bituminous sandstone, utilized for road surfacing, which was supplied by a single quarry in Edmonson County. The output in 1915, which was slightly less than in 1914, is included with that of Texas, to avoid disclosing individual returns.

Oklahoma.—The output in 1915 of natural asphalt in Oklahoma, which comprised the variety grahamite from two localities in Pushmataha County and bituminous sandstone from one locality in Pontotoc County and one locality in Murray County, was decidedly greater than in 1914, the increase being credited in part to grahamite but largely to bituminous sandstone, as a consequence of the opening of a quarry near Ada in Pontotoc County in May. The grahamite produced in Oklahoma is utilized in the manufacture of roofing materials and the bituminous sandstone quarried is absorbed in the paving industry, being used in 1915 in various cities in Oklahoma, Texas, Missouri, and Kansas.

Crude petroleum produced in Oklahoma and Kansas contributed largely to the output of manufactured asphalt in 1915 through refineries located in Illinois and Indiana.

Texas.—Natural asphalt was quarried in Texas in 1915 at only one locality, in Uvalde County. The output of bituminous rock from this source was slightly greater than in 1914. Statistics of marketed production of natural asphalt in Texas are included with the output of Kentucky.

The output in 1915 of manufactured asphalt from Texas and Louisiana petroleum amounted to 100,813 short tons, valued at $1,279,757, or an average price of $12.69 a ton at the four contributing refineries, and included 46,658 short tons of road asphalt and fluxing material, valued at an average price of $1.74 a ton, and 54,155 tons of residual pitch, valued at an average price of $14.38 a ton.

Louisiana.—A small quantity of manufactured asphalt was refined in Texas from crude petroleum produced in Louisiana.

Utah.—The natural hard asphalts, gilsonite and elaterite produced in Utah supply a demand for hydrocarbon material used in the man-

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ufacture of paints, japans, lacquers, varnishes, ready roofing, and rubber compounds, which caused an increase in output of about 7 per cent in 1915. The output of bituminous sandstone in this State, which is utilized in the local paving industry, decreased notably as compared with 1914, the smaller output in 1915 being ascribed by A. V. Taylor [a] to the failure of the State legislature to enact legislation that would permit the assessment of the cost of paving street intersections against abutting property instead of requiring that such paving shall be paid from municipal funds, which are restricted by tax limitations and are rarely more than sufficient for current expenses.

Illinois.—The contribution to the asphalt industry in Illinois in 1915, as in previous years, consisted in supplying crude petroleum for the manufacture of asphalt to three refineries, which had a combined output of 188,575 short tons, valued at the refineries at $1,041,378, the greater part of which was marketed as road asphalt and flux.

Other States.—In addition to the sources of asphalt previously mentioned the following States, containing no commercially developed sources of raw material, contributed to the output of manufactured asphalt in 1915 through refineries treating asphaltic oils produced in adjacent States or imported from Mexico, namely, Indiana, Maryland, New Jersey, Ohio, and Pennsylvania.

Philippine Islands.—Detailed information concerning the distribution, character, geology, and mode of occurrence of the deposits of native bitumen and bituminous rock in the island of Leyte is contained in a report by Mr. Wallace E. Pratt,[b] of the Philippine Bureau of Science, the scope of which is too broad to permit a satisfactory abstract.

IMPORTS.

ASPHALT.

Asphalt imported for consumption in the United States, 1911–1915.

Year.	Crude.		Dried or advanced.		Bituminous limestone.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1911	167,681	$572,198	20,461	$184,954	8,180	$23,468	196,322	$780,236
1912	193,645	726,345	20,707	177,992	3,976	15,808	218,328	921,145
1913	[c] 207,033	738,452	[d] 14,750	133,336	6,395	38,823	228,178	910,611
1914	137,352	664,558	.....	.....	1,705	11,060	139,057	675,618
1915	135,276	661,356	.....	.....	2,976	19,001	138,252	680,357

[a] Taylor, A. V., Oil and hydrocarbons: Salt Lake Min. Rev., vol. 17, No. 18, p. 86, Jan. 15, 1916.
[b] Petroleum and residual bitumens in Leyte: Philippine Jour. Sci., vol. 10, Sec. A, No. 4, July, 1915.
[c] Includes dried or advanced asphalt for last three months of 1913.
[d] Last three months of 1913 included in crude asphalt.

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Asphalt imported for consumption in the United States, 1914–1915, by countries.

Imported from—	1914		1915	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Europe:				
France	100	$1,317	.....	.....
Germany	1,354	10,856	658	$4,854
Italy	247	1,477	492	3,438
Switzerland	620	3,706	200	1,637
England	628	6,269	774	9,801
North America:				
Canada	31	200	35	708
Mexico	140	2,048	56	755
West Indies—				
Barbados	71	6,592	64	6,426
Trinidad and Tobago	61,708	334,635	92,107	498,900
Cuba	458	11,407	391	9,243
South America:				
Colombia	85	5,047	.....	.....
Venezuela	58,755	295,765	28,659	144,595
Asia:				
Turkey	17	3,429	.....	.....
	124,214	682,748	123,436	680,357
Equivalent in short tons	139,057	.....	138,252	.....

In addition to the imports of unmanufactured asphalt in 1915 asphalt products aggregating $681 in declared value were imported for consumption during the year.

The foregoing tables show that the bulk of the asphaltic material obtained by consumers in the United States from foreign sources consists of crude asphalt from Trinidad and Venezuela and indicate that the Trinidad product is more in demand than the Bermudez grades.

OZOKERITE.

The demand in the United States for the cerous hydrocarbon, ozokerite or native paraffin wax has increased notably since the foreign sources of supply were cut off as a consequence of the European war. In May, 1914, the wholesale market prices for ozokerite in New York ranged from 22 cents a pound for the crude brown varieties to 30 cents a pound for crude green. In May, 1916, two years later, corresponding quotations ranged from 45 cents a pound for crude brown to 60 cents a pound for crude green, with only a small quantity available from foreign dealers who had accumulated stocks of ozokerite before the war.

As a consequence of this marked advance in price, renewed interest in the development of the latent ozokerite deposits in Utah and Wasatch counties, Utah, has been aroused, and the Survey is reliably informed that domestic ozokerite will be on the markets before the end of 1916.

An indication of the extent of the demand for ozokerite in this country and of the inability of American consumers to procure an adequate supply of this mineral from foreign sources is found in the following table:

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Mineral wax, chiefly ozokerite, imported for consumption in the United States, 1910–1915.

Year.	Quantity (pounds).	Declared value.	
		Total.	Per pound.
1910	7,988,377	$606,651	$0.076
1911	4,472,708	388,461	.087
1912	6,352,003	488,894	.077
1913	7,141,514	549,992	.077
1914	8,191,529	498,695	.061
1915	2,795,256	210,019	.075

ICHTHYOL.

For a number of years the United States has imported successively greater quantities of a peculiar form of asphaltic material, which, after appropriate chemical treatment, is employed as an antiseptic and alterative medicament under the name ichthyol. The crude material from which it is derived is a bituminous rock, filled with fossil fish that is found in quantity at several localities near Seefeld, in the Austrian Tyrol.

At the outbreak of the European war direct importations of this substance were no longer possible and the subsequent supply, like that of ozokerite, has been furnished by foreign dealers who had accumulated stocks of ichthyol prior to August, 1914. The table below indicates the growth of the domestic market for this pharmaceutical product and shows the inadequacy of the foreign supply that was available in 1915 to meet the needs of American consumers.

As there are no known deposits in the United States of asphaltic material of the peculiar type from which ichthyol is derived, it is a satisfaction to know that American chemists have solved the problem of supplying the domestic needs in this regard and that favorably recommended substitutes for ichthyol, prepared from domestic materials by synthetic methods, are now available in the markets.

Ichthyol imported for consumption, 1910–1915.

Year.	Quantity (pounds.)	Value.
1910	24,663	$35,111
1911	42,589	65,715
1912	51,502	69,670
1913	58,485	83,084
1914	61,416	86,415
1915	24,921	28,560

EXPORTS.

The foreign trade of the United States in asphalt and asphalt products expanded slightly in 1915 as compared with 1914, the quantity of manufactured asphalt exported increasing from 37,246 long tons in 1914 to 38,203 long tons in 1915 and the declared value of the asphalt products sent out increasing from $401,182 in 1914 to $438,685 in 1915. The principal increase in foreign shipments of unmanufactured asphalt was to England and to Canada, whereas

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appreciable decrease was apparent in the exports to Germany, Cuba, and Chile.

The following tables have been compiled from the records of the Bureau of Foreign and Domestic Commerce.

Asphalt exported from the United States, 1912–1915.

Year.	Unmanufactured.		Manufactures (value).	Total value.
	Quantity (long tons).	Value.		
1912	39,915	$896,678	$467,959	$1,354,637
1913	58,550	1,267,625	411,786	1,679,411
1914	37,246	845,838	401,182	1,247,020
1915	38,203	735,952	438,685	1,174,637

Asphalt exported from the United States, 1914–1915, by countries.

Exported to—	1914			1915		
	Unmanufactured.		Manufactures (value).	Unmanufactured.		Manufactures (value).
	Quantity (long tons).	Value.		Quantity (long tons).	Value.	
Europe:						
Austria-Hungary	412	$8,886				
Belgium	416	9,596	$405			
Denmark	130	2,191		63	$2,533	$287
France	559	14,304	162	340	9,915	5,678
Germany	4,495	106,553	23,179			
Italy	21	494	2,703			4,058
Netherlands	1,888	46,704		3	93	93
Norway				3	80	
Roumania			3,151			
Russia in Europe	5	101		50	3,966	
Spain	120	2,419	11,162	125	2,787	10,263
Sweden			238			1,444
Switzerland						136
England	3,585	76,651	41,401	8,782	203,160	66,920
Scotland	177	3,648		451	9,964	1,885
Ireland	40	806	4,684	98	5,214	4,315
North America:						
Bermuda						3
Canada	16,275	322,969	284,460	25,868	438,696	188,634
Central American States—						
Costa Rica			12			
Guatemala			74			79
Honduras			7			196
Nicaragua						20
Panama	217	5,282	7,230	9	216	10,085
Mexico	32	880	2,903	35	800	4,094
Newfoundland			72			
West Indies—						
Cuba	4,139	100,999	2,499	1,445	32,280	3,662
Dominican Republic			40	11	298	120
British—						
Jamaica			24			40
Other British Indies						14
South America:						
Argentina	1,775	47,445	65	556	12,868	18,453
Bolivia	2	40				
Brazil	1,068	38,808	1,942	168	7,353	33,075
Chile	1,384	42,858	1,877	8	280	17,172
Columbia				2	100	267
British Guiana	2	33				42
Ecuador	5	208				36
Peru			346			
Uruguay				5	154	961
Venezuela			102			55

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Asphalt exported from the United States, 1914–1915, by countries—Continued.

Exported to—	1914			1915		
	Unmanufactured.		Manufactures (value).	Unmanufactured.		Manufactures (value).
	Quantity (long tons).	Value.		Quantity (long tons).	Value.	
Asia:						
China	55	$1,218	$57	16	$454	$11,532
China, territory leased to Japan	39	906	.....	.....	.....	.....
East Indies—						
British India	.....	.....	1,348	.....	.....	3,714
Straits Settlements	.....	.....	173	.....	.....	1,599
Other British	.....	.....	120	.....	.....	1,080
Dutch	.....	.....	61	.....	.....	1,500
French	.....	.....	.....	.....	.....	321
Hongkong	.....	.....	71	.....	.....	4,427
Japan	24	577	4,312	.....	.....	6,278
Siam	.....	.....	120	.....	.....	591
Oceania:						
British—						
Australia	264	8,931	1,653	134	3,981	10,699
New Zealand	4	115	1,509	.....	.....	7,985
German	.....	.....	.....	.....	.....	288
Philippine Islands	40	759	2,803	.....	.....	16,464
Africa:						
British South Africa	72	1,474	200	8	200	200
German	1	33	.....	.....	.....	.....
Egypt	.....	.....	27	.....	.....	.....
Portuguese Africa	.....	.....	.....	23	575	.....
	37,246	845,838	401,182	38,203	735,952	438,685
Equivalent in short tons	41,716	.....	.....	42,787	.....	.....

CONSUMPTION.

The quantity of asphaltic material actually consumed in the United States is not susceptible of accurate determination. The sum of the quantity marketed from domestic sources and the quantity imported less the quantity exported in a given year provides, however, an approximation of the quantity consumed that is not without value in the absence of more specific data. On this basis the consumption of asphaltic material, including both natural and manufactured varieties, in 1915 amounted to 1,224,037 short tons, as compared with 851,699 short tons in 1914, computed by the same method.

The principal use of asphaltic material in the United States is for highway and pavement construction and maintenance, the country-wide movement toward better roads and quieter and more sanitary pavements creating a demand for all types of asphalt that shows a steady annual increase. Data are not available as to the quantity of asphalt utilized in road and pavement construction, but the following statistics[1] of asphalt pavement (including both natural and manufactured asphalt) constructed in a number of typical cities in 1915 indicate the general popularity of asphalt for street improvement purposes:

[1] Engineering and Contracting, vol. 45, No 14, Apr. 5, 1916.

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Asphalt pavement constructed in 1915 in various cities.

	Square yards.
Massachusetts:	
Boston	33,928
Springfield	14,271
Connecticut:	
Derby	1,005
Hartford	29,873
New Haven	50,380
Stamford	20,814
Rhode Island:	
Providence	27,628
New York:	
Albany	42,452
Geneva	[1] 17,469
New York (Bronx)	51,169
New York (Richmond)	142,347
Schenectady	133,365
Syracuse	82,775
New Jersey:	
Camden	31,796
Harrison	4,241
Jersey City	2,974
Passaic	35,932
Pennsylvania:	
Allentown	42,975
Erie	20,761
Harrisburg	38,551
Johnstown	25,127
Philadelphia	327,790
Pittsburgh	[2] 14,927
Pittsburgh	25,378
Scranton	28,114
Wilkes-Barre	40,024
York	20,597
Maryland:	
Baltimore	239,912
Ohio:	
Cincinnati	29,732
Columbus	12,269
Lakewood	24,500
Lakewood	11,207
Toledo	61,285
Urbana	11,600
Youngstown	8,890
Indiana:	
Fort Wayne	39,003
Indianapolis	311,940
Richmond	18,748
South Bend	7,760
Wabash	10,964
Illinois:	
Chicago	854,681
Moline	28,088
Peoria	[1] 28,645
Rock Island	13,932
Michigan:	
Bay City	31,491
Detroit	26,476
Flint	73,800
Michigan—Continued.	
Grand Rapids	8,100
Saginaw	25,256
Wisconsin:	
Appleton	20,000
Beloit	55,000
Milwaukee	227,833
Minnesota:	
Duluth	4,757
St. Paul	10,012
Iowa:	
Cedar Falls	45,857
Davenport	4,805
Fort Dodge	23,445
Waterloo	5,100
Missouri:	
Kansas City	72,584
District of Columbia:	
Washington	35,745
West Virginia:	
Charleston	1,317
North Carolina:	
Concord	13,897
Durham	2,052
Greensboro	48,100
South Carolina:	
Anderson	70,000
Charlotte	37,144
Columbia	51,532
Greenville	10,000
Kentucky:	
Lexington	27,170
Tennessee:	
Chattanooga	[1] 13,075
Mississippi:	
Vicksburg	81,044
Louisiana:	
New Orleans	37,820
Oklahoma:	
Ardmore	1,800
Tulsa	60,000
Texas:	
Dallas	[3] 35,190
Hillsboro	[3] 9,155
Utah:	
Salt Lake City	6,549
Salt Lake City	[3] 66,165
California:	
Long Beach	134,017
Oakland	57,649
Pomona	150,611
Vallejo	[3] 11,730
Washington:	
Everett	16,301
Oregon:	
Eugene	14,438
Portland	4,285

[1] Resurfacing. [2] New work. [3] Rock asphalt.

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ASPHALT INDUSTRY IN PRINCIPAL COUNTRIES.

The following table shows the output of natural asphalt (all forms) in the principal producing countries, by calendar years, except as otherwise stated, from 1906 to 1915, inclusive, as far as reliable statistics are available:

Asphalt and bituminous rock produced in principal producing countries, 1906–1915.

Year.	United States.		Trinidad.[a]		Germany.		Cuba.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1906	73,062	$674,934	150,373	$832,964	129,388	$268,631	5,717	$26,606
1907	85,913	928,381	171,271	832,274	139,567	264,494	5,571	37,594
1908	78,565	517,485	143,552	403,023	98,088	188,334	6,875	31,574
1909	99,061	572,846	159,416	459,446	85,446	176,897	11,900	48,246
1910	98,893	854,234	157,120	421,419	89,491	152,565	2,320	13,685
1911	87,074	817,250	[b] 201,284	[c] 494,000	90,256	154,938	3,638	21,928
1912	95,166	865,225	[b] 212,236	[c] 521,000	105,950	200,743	17,260	87,500
1913	92,604	750,713	[b] 257,635	[c] 633,000	.....	.....	[b] 1,749	30,935
1914	79,888	642,123	[b] 163,076	[c] 400,411	.....	.....	[b] 909	19,491
1915	75,751	526,490	.....	.....	.....	.....	[d] 149	3,564

Year.	France.		Italy.[e]		Spain.		Japan.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1906	216,405	$345,599	144,802	$349,926	8,587	$17,130	43	$3,572
1907	195,136	330,065	178,127	442,014	9,057	16,001	644	5,436
1908	188,616	264,188	148,433	368,306	13,635	24,084	2,650	25,564
1909	186,298	269,161	123,361	306,159	5,822	10,282	4,614	45,205
1910	187,085	277,210	179,261	452,911	7,072	18,308	526	29,004
1911	.....	.....	207,926	501,550	[f] 4,124	8,754	1,389	13,728
1912	.....	.....	200,560	581,283	5,938	13,003	3,199	32,518
1913	.....	.....	188,601	521,398	.....	.....	.....	.....
1914	.....	.....	.....	.....	.....	.....	.....	.....
1915	.....	.....	.....	.....	.....	.....	.....	.....

Year.	Austria-Hungary.		Russia.		Venezuela.		Mexico.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1906	10,633	$778,781	[g] 12,517	$110,294	[b] 22,128	$98,250	1,531	$17,174
1907	11,335	727,892	[g] 14,116	101,705	[b] 37,637	167,938	4,945	182,265
1908	12,239	768,162	[g] 24,961	491,302	[b] 31,539	141,912	5,811	330,903
1909	11,179	663,246	[h] 2,665	4,599	[b] 37,292	180,061	6,031	106,484
1910	9,070	702,022	[h] 27,544	176,518	[b] 31,890	[e] 151,000	3,140	39,681
1911	[h] 8,312	652,603	.....	.....	[b] 50,163	[c] 238,000	8,912	125,322
1912	[h] 11,439	664,778	.....	.....	[b] 65,875	[e] 312,000	33,611	462,230
1913	.....	.....	.....	.....	[b] 83,825	[c] 400,000	.....	.....
1914	.....	.....	.....	.....	[b] 44,590	.....	.....	.....
1915	.....	.....	.....	.....	[b] 28,526	.....	.....	.....

[a] Includes small quantity of manjak, produced in Barbados.
[b] Exports.
[c] Estimated.
[d] Exports for six months.
[e] Only about 7 per cent of the quantity given represents asphalt, the remainder being bituminous sandstone and limestone.
[f] In addition 6,306 tons of bituminous rock were produced, no value being reported.
[g] Includes mineral pitch.
[h] Includes ozokerite.

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TRINIDAD.

The effects of the European war on the asphalt industry of Trinidad are plainly shown in the accompanying table, which is presented through the courtesy of the Barber Asphalt Paving Co. European demand for Trinidad asphalt, which has averaged about the same as that of the United States prior to 1915, fell off more than 57,000 long tons in that year as compared with 1914. This loss was, however, largely made up by increased shipments to the United States, which required nearly 49,000 long tons more in 1915 than in 1914, so that the net decrease in asphalt exports was only about 9,500 long tons, or 6.5 per cent of the exports in 1914.

Asphalt exported from Trinidad, 1911–1915, in long tons.

Year.[a]	To United States.			To Europe.			To other countries.			Grand total.
	Lake.	Land.	Total.	Lake.	Land.	Total.	Lake.	Land.	Total.	
1911	108,590	3,040	111,630	67,105	.....	67,105	983	.....	983	179,718
1912	95,111	8,600	103,711	85,299	.....	85,299	486	.....	486	189,496
1913	123,873	1,400	125,273	104,153	.....	104,153	605	.....	605	230,031
1914	67,357	2,950	70,307	75,297	.....	75,297	.....	.....	.....	145,604
1915	118,001	1,250	119,251	18,025	.....	18,025	.....	.....	.....	136,026

[a] Ending Jan. 31 of year succeeding.

VENEZUELA.

That the European war has adversely affected the asphalt industry of Venezuela is shown in the following statement, dated March 4, 1916, of United States Consul Homer Brett, at La Guaira, contained in Commerce Reports, issue of March 29, 1916:

Shipments of asphalt from Cristobal Colon are greatly cramped by the high ocean freights now prevailing. Before the war one steamer weekly was dispatched, while only one a month is going forward at present.

Of further interest as indicating a possible future source of asphalt in Venezuela this report notes the issuance of a lease to Señor Guillermo Pimentel Troconis on a mining claim near the city of Puerto Cabello for the production of asphalt, petroleum, etc.

Supplemental information concerning this contract is to the effect that the area involved is 494 acres, that the term of the lease is 25 years, that a certain royalty per ton of product exploited is required in addition to the ground rental, that machinery for development may be imported free of duty but reverts to the Government at the expiration of the lease, and that during the period of exploitation the Government shall have a preferential right to purchase such quantities of asphalt and petroleum as it may require at a discount of 20 per cent from the market price.

CUBA.

Little is being done in the way of development of the abundant deposits of asphalt in the island of Cuba. In order to understand this condition of inactivity it is only necessary to consider the geographical position of Cuba, adjacent not only to the sources of the purest natural asphalt known, in Trinidad and Venezuela, but to

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the large sources of manufactured asphalt in the United States and Mexico.

The following table shows the trend of the Cuban asphalt industry in the last five years:

Asphalt exported from Cuba, 1911–1915.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1911	3,248	$21,629	1914	865	$19,491
1912	15,410	86,303	1915 (six months)	133	3,564
1913	1,562	30,935			

CANADA.

Interest in the vast undeveloped sources of bituminous sand in northern Alberta, recently described by S. C. Ells,[1] received a marked impetus in 1915 as a result of the successful completion in Edmonton of a section of pavement laid with this material and of the rapid progress made on construction work on the Alberta & Great Waterways Railway from Edmonton to McMurray, which, it is expected, will provide an outlet to markets for this type of asphalt before the end of 1916.

[1] The bituminous sands of northern Alberta: Canada Dept. Mines, Mines Branch, Rept. 281, 1914.

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GYPSUM.[1]

By R. W. Stone.

PRODUCTION.

Although the output of gypsum mined decreased in 1915, the decrease was only a little more than 1 per cent, and the decrease in value of products marketed was only about 4 per cent. As a matter of fact, the quantity mined exceeded that of all previous years except three, 1912, 1913, and 1914, as shown by the accompanying table:

Crude gypsum mined in the United States, 1880–1915.

	Short tons.		Short tons.		Short tons.
1880	90,000	1892	256,259	1904	940,917
1881	85,000	1893	253,615	1905	1,043,202
1882	100,000	1894	239,312	1906	1,540,585
1883	90,000	1895	265,503	1907	1,751,748
1884	90,000	1896	224,254	1908	1,721,829
1885	90,405	1897	288,982	1909	2,252,785
1886	95,250	1898	291,638	1910	2,379,057
1887	95,000	1899	486,235	1911	2,323,970
1888	110,000	1900	594,462	1912	2,500,757
1889	267,769	1901	633,791	1913	2,599,508
1890	182,995	1902	816,478	1914	2,476,465
1891	208,126	1903	1,041,704	1915	2,447,611

There was an increase in the quantity of gypsum sold without calcining for use in Portland cement but a decrease in its value, due to a decline in the price per ton. There was also an unusual increase in the quantity sold as land plaster, and the decrease in the average price per ton was thus more than counterbalanced, so that there was an increase in the value as well.

The quantity of calcined gypsum sold in 1915 was about 42,000 tons less than in 1914 but greater than in any year prior to 1912. There was a decrease of a few cents in average price per ton in most classes of gypsum products.

Gypsum was produced in 18 States and in Alaska. New York was the largest producer of raw gypsum, Iowa ranked second, and Michigan was third. Sales of gypsum products are credited to Illinois, Minnesota, Washington, and Wisconsin, although these States are not producers. This is the necessary result of the trend of the gypsum industry toward assembling calcined gypsum, retarder, fiber, and sand, and preparing plasters for the market at local mixing mills, from which they may be more readily and economically distributed to the trade territory. Sales reported to the Survey from mixing plants and warehouses are credited to the State in which the plants are located.

[1] The statistical data in this report were compiled by Miss L. M. Jones, statistical clerk.

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The following tables summarize the gypsum industry in 1914 and 1915:

Gypsum marketed in the United States, 1914 and 1915, by States and uses.

1914.

State.	Number of mills reporting.	Total quantity mined (short tons).	Sold without calcining.				Sold as calcined plaster.		Total value.
			Ground for land plaster.		For Portland cement, paint, and other purposes.		Quantity (short tons).	Value.	
			Quantity (short tons).	Value.	Quantity (short tons).	Value.			
Alaska, Arizona, Colorado, Illinois,[a] Minnesota,[a] Montana, Nevada, New Mexico, Oregon, South Dakota, Virginia, Washington,[a] Wisconsin[a]	15	358,363	14,193	$34,922	47,301	$122,741	238,497	$1,162,584	$1,320,247
California	9	27,376	5,199	14,334	12,921	30,710	24,787	139,842	184,886
Iowa	5	480,404	12,251	14,920	52,934	45,566	335,065	1,260,971	1,321,457
Kansas	4	80,774	(b)	(b)	[b] 23,796	[b] 22,531	47,877	255,812	278,343
Michigan	8	393,006	9,322	10,761	51,905	40,481	249,648	654,599	705,841
New York	7	523,368	6,540	12,535	172,279	247,307	279,449	977,350	1,237,192
Ohio	4	265,091	(b)	(b)	[b] 8,189	[b] 13,156	220,126	760,257	773,413
Oklahoma	6	113,103	(c)	(c)	(c)	(c)	[c] 91,419	[c] 312,856	312,856
Texas	4	158,814			(c)	(c)	[c] 133,478	[c] 490,937	490,937
Utah	3	44,950	(b)	(b)	[b] 7,639	[b] 14,741	33,401	169,880	184,621
Wyoming	3	31,216					21,537	86,196	86,196
	68	2,476,465	52,945	97,716	390,742	549,083	1,656,066	6,249,190	6,895,989

1915.

Alaska, Arizona, Colorado, Illinois,[a] Minnesota,[a] Montana, Nevada, New Mexico, Oregon, South Dakota, Virginia, Washington,[a] Wisconsin[a]	16	319,164	25,089	$52,596	49,025	$108,746	215,492	$1,073,957	$1,235,299
California	3	32,559	(c)	(c)	(c)	(c)	[c] 29,060	[c] 113,863	113,863
Iowa	5	496,860	12,086	11,422	59,823	48,508	335,057	1,218,198	1,278,128
Kansas	4	60,919	(b)	(b)	[b] 17,332	[b] 14,887	40,634	235,127	250,014
Michigan	8	389,791	(b)	(b)	[b] 69,572	[b] 63,236	245,484	623,073	686,309
New York	11	540,914	9,262	17,463	175,255	251,004	293,870	999,239	1,267,706
Ohio	4	259,036	4,030	6,485	5,131	6,485	217,811	759,550	772,520
Oklahoma	5	110,790	(b)	(b)	[b] 17,580	[b] 15,784	73,348	278,446	294,230
Texas	5	176,306	(c)	(c)	(c)	(c)	[c] 148,138	[c] 519,879	519,879
Utah	3	23,445	(c)	(c)	(c)	(c)	[c] 20,541	[c] 75,835	75,835
Wyoming	5	38,827					25,749	103,110	103,110
	69	2,447,611	69,256	122,714	406,393	528,161	1,613,720	5,946,018	6,596,893

[a] No crude gypsum produced in the State.
[b] Some land plaster included with gypsum sold for Portland cement, etc.
[c] Some crude gypsum included with calcined plaster.

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Gypsum marketed in the United States, 1911–1915, by uses.

Year.	Sold without calcining.														
	For Portland cement.			As land plaster.			For paint material.			For other purposes.			Total.		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
1911	327,953	$484,373	$1.48	52,880	$97,573	$1.85	(a)	(a)	.....	a 6,647	$7,533	$1.13	387,480	$589,479	$1.52
1912	382,952	509,400	1.33	53,065	107,058	2.02	(a)	(a)	.....	a 5,591	7,064	1.26	441,608	623,522	1.41
1913	408,221	600,913	1.47	54,815	95,953	1.75	(a)	(a)	.....	a 100	200	2.00	463,136	697,066	1.51
1914	b 390,742	b 549,083	1.41	52,945	97,716	1.85	(b)	(b)	.....	.....	.....	.....	443,687	646,799	1.46
1915	b 406,393	b 528,161	1.30	69,256	122,714	1.77	(b)	(b)	.....	.....	.....	.....	475,649	650,875	1.37

Year.	Sold calcined.														
	As plaster of Paris, wall plaster, Keenes cement, etc.			For dental plaster.			To glass factories.			For Portland cement and other purposes.			Total.		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
1911	1,523,263	$5,678,453	$3.73	413	$2,612	$6.32	33,472	$80,220	$2.40	41,270	$111,271	$2.70	1,598,418	$5,872,556	$3.67
1912	1,678,417	5,805,999	3.46	c 3,190	15,564	4.88	24,159	52,741	2.18	25,908	66,082	2.55	1,731,674	5,940,386	3.43
1913	1,680,157	5,858,785	3.49	861	4,168	4.84	10,942	21,797	1.99	81,889	193,006	2.36	1,773,849	6,077,756	3.43
1914	1,565,937	6,038,777	3.86	641	3,374	5.26	(d)	(d)	.....	d 89,488	207,039	2.31	1,656,066	6,249,190	3.77
1915	1,520,308	5,776,826	3.80	534	2,376	4.45	11,861	26,620	2.25	81,017	140,196	1.73	1,613,720	5,946,018	3.68

a Paint material included under "For other purposes."
b Small quantity of paint material included with gypsum sold for Portland cement.
c Includes some casting plaster.
d Calcined gypsum sold to glass factories included under "For Portland cement and other purposes."

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IMPORTS.

Gypsum imported into the United States comes almost wholly from Nova Scotia and New Brunswick and enters the ports of the New England and North Atlantic States, over one-half of it entering the port of New York. The value of imports from 1889 to 1898 averaged about one-third of the value of domestic production, but since 1899 the proportionate value of imports has become very small and seems to be steadily decreasing. It amounted to less than one-twelfth of the value of the domestic production in 1913, a little more than one-sixteenth in 1914, and somewhat more than one-seventeenth in 1915.

Gypsum imported and entered for consumption in the United States, 1911–1915.[a]

Year.	Unground.		Ground or calcined.		Value of manufactured plaster of Paris.	Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.		
1911	389,874	$413,119	388	$3,353	$34,334	$450,806
1912	412,697	430,183	3,702	19,709	38,589	488,481
1913	447,383	473,594	4,542	31,277	52,051	556,922
1914	369,214	392,118	3,559	27,931	24,792	444,841
1915	336,856	356,791	5,749	22,873	10,095	389,759

[a] Figures compiled from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

PRODUCTION IN CANADA.[1]

Production of gypsum in Canada, 1914–1915.

Year.	Quantity (short tons).	Value.
1914	516,880	$1,156,207
1915	470,335	849,928

The gypsum sold in 1915 was classified as follows: Lump, 342,467 tons; crushed, 48,735 tons; fine ground, 6,455 tons; calcined, 72,678 tons.

In 1914 the quantities of the various grades were: Lump, 351,729 tons; crushed, 49,441 tons; fine ground, 6,097 tons; and calcined, 109,613 tons.

TRADE AND MANUFACTURING CONDITIONS.

The average price of both raw and calcined gypsum decreased 9 cents a ton in 1915. One new mill was in operation in 1915 in New York. There were 77 active gypsum mines, quarries, and pits in the United States and Alaska, which supplied 69 domestic plants. Of these 69 plants, 50 used gypsum, 10 used gypsite, 7 used both gypsum and gypsite, 1 reported the use of selenite crystals, and 1

[1] Preliminary report on the mineral production of Canada during the calendar year 1915, Canada Dept. Mines, Mines Branch.

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used gypsum sand. Thirty-two plants obtained their material quarries and open pits, 30 from mines, and 7 from mines and qua Seven plants sold ground gypsum only, 30 sold only calcined r rial, and 32 sold both calcined and uncalcined gypsum.

Of the 62 calcining plants, 53 were equipped with kettles, 3 with rotary kilns, 5 with stationary kilns, and 1 with a baffle-plate furnace. There were 163 calcining kettles in operation.

The fuel used at 40 calcining plants was coal; oil was used at 18 plants, wood at 2 plants, and coke at 2 plants. The oil-burning plants are in Arizona, California, Kansas, Nevada, New Mexico, Oklahoma, Oregon, Texas, and Washington.

These summaries do not include the equipment of several plants termed "mixing mills," which are auxiliary mills established at commercial centers, such as Chicago, Ill., Milwaukee and Superior, Wis., St. Paul, Minn., and Cleveland, Ohio. These mills do no calcining, but receive the calcined plaster and prepare it for the market in various forms by the addition of fiber, retarder, and sand.

Six plants reported the manufacture of Keenes cement, and 12 plants reported making gypsum block, tile, or board.

Gypsum was calcined in 1915 at plants located in the following places:

Arizona: Douglas.
California: Amboy, Los Angeles.
Colorado: Loveland, Portland.
Iowa: Fort Dodge.
Kansas: Blue Rapids, Medicine Lodge.
Michigan: Alabaster, Grand Rapids, Grandville.
Montana: Great Falls.
Nevada: Arden, Moundhouse.
New Mexico: Acme, Alamogordo, Oriental.
New York: Akron, Garbutt, Oakfield, Wheatland.
Ohio: Castalia, Gypsum, Port Clinton.
Oklahoma: Acme, Eldorado, Okeene, Primm, Southard.
Oregon: Gypsum.
South Dakota: Black Hawk, Rapid City.
Texas: Acme, Plasterco.
Utah: Nephi, Sigurd.
Virginia: North Holston, Plasterco.
Washington: Tacoma (using Alaska gypsum).
Wyoming: Basin, Greybull, Laramie, Red Buttes.

Gypsum from Nova Scotia was calcined in 1915 at Brooklyn, New Brighton, Newburgh, and New York City in New York State, and at Chester in Pennsylvania.

KEENES CEMENT.

A hard-finish wall plaster manufactured at gypsum mills is known as "Keenes cement." It differs from ordinary gypsum wall plasters in method of manufacture, time of setting, and superior hardness. Pure gypsum is burned at a low temperature so as to convert it into the hydrate ($2CaCO_4.H_2O$); the lumps are soaked in a solution of alum, aluminum sulphate, or borax, and are then recalcined at about 500° C. (932° F.). On grinding, they give Keenes cement. According to another method the gypsum in small lumps is calcined in small vertical kilns similar to lime kilns and so constructed that only the gaseous products of combustion come into contact with the gypsum, in order to avoid contaminating it with the ash of the fuel. The gypsum is brought to a red heat, after which it is treated with a 10 per cent solution of alum and allowed to dry. It is again calcined, this time to a dull red heat, and then ground to flour. Keenes cement is made at some plants in the United States by a simpler method, concerning which there is some secrecy.

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METHOD OF PREPARING GYPSUM FOR USE.

Rock gypsum is mined or quarried, according to its relation to the surface and to the character and thickness of the overburden. Gypsum beds in most places lie nearly flat, and in underground work the room and pillar system of mining is followed, as in mining flat lying coal beds. Gypsite or gypsum earth always lies close to the surface, is soft, and is dug by hand or taken up by the use of plow and scraper. Rock gypsum is put through mills which crush it to pieces less than one-half an inch in size; then it passes through a drier, a large rotating cylindrical tube. The crushed rock is fed into one end of the drier and hot gases into the other end. In passing through, the superficial moisture is driven off from the gypsum, which is delivered at a temperature of approximately 100° F., ready for pulverizing. Various types of pulverizers are used, including burr mills, emery mills, disintegrators, and the pulverizing and air-separating system. These reduce the rock to powder of such a fineness that 80 per cent will pass a 100-mesh screen.

The pulverized gypsum is raised by elevators to storage bins at the top of the building and flows by gravity to the calciners, the common type being stationary kettles. A calcining kettle has a diameter of 8 to 14 feet and a depth of 6 to 10 feet, is set over a masonry fire box, and is surrounded by a shell of brick. Coal is burned under the kettle and the heat makes the gypsum fed into the kettle give off its water of crystallization in the form of steam. This steam, passing through the material, floats it up so that by the time the kettle is full the material resembles a boiling fluid. When the calciner is full the feeding process is stopped. Cooking is continued until the gypsum is calcined or the proper amount of moisture has been driven off. Then gates are opened at the bottom and the hot powder flows out, usually upon a conveyor, which moves the calcined gypsum to another part of the mill where it may be reground and screened before going to the mixing machines. In the warehouse a small quantity of retarder is added to the calcined gypsum to regulate the time of set, and other materials, such as hair, manila fiber, cut-wood fiber, and sand may be added to increase the strength or volume of the plaster. These materials are added in varying proportions to make the different kinds of plaster required by the trade. They are blended with the calcined gypsum in a mixing machine, which feeds into an automatic sacking machine.

The cost of a gypsum plaster mill varies with capacity and type of mill, availability and kind of building material, and conditions of labor and transportation. Estimates of approximate cost of plaster mills, wood construction, including necessary buildings, mills, kettles, conveyors, bins, complete are: Capacity, 25 tons in 24 hours, 60 horsepower steam plant, cost $7,000 to $9,000; capacity, 100 tons in 24 hours, 150 horsepower steam plant, cost $25,000 to $30,000.

A mill with steel construction and fireproof throughout will cost considerably more.

USES OF GYPSUM.

UNCALCINED.

Uses.—As shown in the foregoing tables, nearly half a million tons of gypsum is sold annually without calcining. The bulk of this

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material is used for retarder in Portland cement. Minor quantities are used as a pigment base for paints, in making cold water paints, crayons, as filler for paper and cloth, as base for insecticides, and as land plaster or fertilizer. The last use, which consumed nearly 70,000 tons in 1915, is one that has been practiced for many years but which would be increased very materially if the farmers would spread gypsum in their stables where it would do the most good. So little has been said in these annual reports on this particular subject that the following paragraphs are offered in explanation.

Gypsum on the farm.—One of the first uses made of gypsum in this country was as land plaster, and for many years it was the principal use. For this purpose the rock is ground to a fine powder but not calcined. Raw gypsum applied to some soils has a beneficial effect with some crops, especially clover, peanuts, alfalfa, and other legumes. The action of gypsum as a fertilizer is indirect and not as a plant food itself. It is supposed to act on the double silicate of magnesia and potash, setting them free to act as plant food. The necessary elements must first be present in the soil to obtain any beneficial effect. In other words, the application of gypsum to some soils would be ill-advised.

Land plaster, it is claimed, tends to make nonporous clay soils more pervious to water and to make sandy soils less pervious and is of benefit in sweetening sour and acid soils. Another characteristic of ground gypsum is that it has an affinity for water and will draw moisture from the atmosphere. This quality is a great factor in keeping moisture in the soil and is of value to the farmer in starting the growth of grain and grass, as it holds moisture where the roots of the small plants most need it. The application of ground gypsum or land plaster to the foliage of many plants in a dry hot season will draw the necessary moisture from the atmosphere to save a crop from being damaged by drought. It is commonly applied to peanut vines to insure a crop.

Perhaps the greatest advantage from the use of ground gypsum by the farmer is had by a liberal application of it on stable litter and manure to conserve ammonia. Ammonia is a chemical compound composed of 82 per cent nitrogen and 18 per cent hydrogen. Nitrogen is one of the most valuable plant foods and soil ingredients and is also one of the most difficult to conserve. One of the characteristics of nitrogen is that it is always trying to get away. Every farmer knows that the manure from the stables is rich in ammonia and that the ammonia ordinarily escapes from the manure before he can get it spread on the land. The valuable plant food, nitrogen, contained in the manure is therefore lost. The liberal use of ground gypsum around the stables and on the manure prevents the escape of the ammonia, chemically fixes the nitrogen, keeps the manure from heating and burning, kills the odor, and reduces the attraction for flies. It is therefore of great advantage to the farmer to make daily free use of land plaster in his stables. It should be applied to the litter and manure at the rate of from 5 to 10 pounds per animal per day. This daily use mixes the plaster thoroughly with the manure with which it will be applied to the soil and results in saving for plant food the nitrogen that would otherwise escape into the air.

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Land plaster may be applied to the soil by drilling or may be sowed broadcast. When applied in this manner it should be used at the rate of 200 to 500 pounds per acre.

CALCINED.

Calcined gypsum amounting to about a million and a half tons annually is used as wall plaster. This use and the qualities of the plaster, such as hardness, quick set, fire resistance, and poor conductivity of heat and cold, are so well known that further discussion will not be given here.

The making of gypsum board, tile, and screed is the newest branch of the industry and has not yet attained any considerable proportions; at least, the total value of the annual production of this material is probably less than $200,000. The statistical cards sent out by the Geological Survey do not ask specifically for reports on these products. Nevertheless, the reports for 1915 show that they were made at 12 plants in that year.

Gypsum plaster boards are of various types, mainly consisting of gypsum mixed with fibrous binding material to give strength and toughness for effective nailing. A type of plaster board in common use consists of four alternate layers of wool felt with three intermediate layers of gypsum. Other boards contain but two layers of felt with a gypsum layer between. In order to meet the joint and stud spacing of standard construction, plaster boards are usually 32 by 36 inches (8 square feet) and are made one-fourth, three-eighths, and one-half inch in thickness. The wool felt binding material forming the outside surface of the plaster boards is an excellent bonding surface for gypsum plaster. Plaster boards are used for lathing in place of wood or metal lath on surfaces that are to be plastered and where high fire-resistive construction is required. In fireproof construction the plaster boards are fastened to metal studs or hangers by metal clips. On surfaces not to be plastered plaster boards are used for deadening sound by being laid between rough and finished floors; as sheathing boards by being nailed to the studding and behind the clapboards; as outside sheathing, which is waterproofed before application of outside stucco covering; as insulation and fire resistance under wood shingles, in air ducts, and in dumb-waiter shafts.

Gypsum floor screeds are used as a nailing sleeper for floors. They are 2 by 3 inches and 8 feet long and weigh 2 pounds per linear foot. They do not rot or burn.

Gypsum tile is made for partitions, floors, roofs, and furring. Partition tile, solid or hollow, is 12 by 30 inches wide and 2 to 8 inches thick. These tiles, laid with gypsum plaster, are used in the highest type of fireproof building for dividing and corridor partitions, in elevator and stairway inclosures, and in dumb-waiter shafts; they are light in weight, can be laid very rapidly, can be cut with a handsaw, and, when plastered with gypsum, make partitions of high heat-resistive value.

Gypsum floor tile is a hollow box or dome of reinforced gypsum plaster, used as a filler between concrete joist construction. These tiles are 19 inches wide and 24 inches long, 7, 9, 11, and 13 inches high, and weigh 24, 27, 30, and 33 pounds per linear foot; they afford

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a saving in dead weight of construction and provide a smooth, all-gypsum ceiling to plaster upon.

Gypsum roof tile is made 24 and 30 inches long, 12 inches wide, and 3 inches thick, and is laid between supporting subpurlin "T" irons. Larger gypsum roof tile, reinforced and made of especially hard gypsum, are made to span 4 feet and are laid upon the main roof purlins. These tile are 4½ inches thick, 18 inches wide, and of biscuit pattern. All these roof tiles weigh 13 pounds per square foot and are light and noncondensing. The low heat conductivity of gypsum is an especially valuable quality in a roof deck. Slate or any other roof covering can be nailed or otherwise secured to the smooth decks of gysum roof tile.

Gypsum furring tile are of the same character and general dimensions as the partition tile, are hollow or solid, and are 2 inches thick. They are fastened to the wall by nailing and are used for sound absorption and soundproofiing, fire protection, insulation from heat or cold, and damp proofing.

Other uses for calcined gypsum which have been in practice longer than those just described, are in making statuary and other art work, relief maps and models, molds for rubber stamps, molds for pottery and terra cotta, in bedding plate glass for polishing, in foundry molds for special castings, and in making surgical casts. Calcined gypsum enters into the composition of match heads, hat blocks, relief decorations for walls and ceilings, asbestos pipe covering, and is used for various other purposes.

The Geological Survey has in preparation for publication a report on gypsum deposits in the United States and a paper on methods of preparing gypsum for use. Notice of these publications will be sent to the newspapers of the country when they are ready for distribution.

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BARYTES AND STRONTIUM.

By JAMES M. HILL.

INTRODUCTION.

With the report on barytes and strontium in 1915 the Geological Survey is endeavoring to extend its usefulness. Heretofore the annual reports on these minerals have dealt only with the output of the crude materials and have not attempted to present much information relative to the uses of crude barytes. It was known that the crude material found a considerable market, but not until the middle of 1914 was the demand for this material in the chemical industry appreciated. In August, 1914, began a series of inquiries from consumers of barytes for domestic supply which led to a voluminous correspondence, but the Survey had little information regarding the products made from crude barytes. Consequently, the desire to be of service not only to the producers but also to the users of barytes led the Survey to undertake a canvass of the new chemical industry. In this work it met the cordial cooperation of the whole industry, to the members of which its thanks are due for the confidential statements and reports so generously given.

The owners of strontium-bearing deposits in the United States have likewise made reports, and inquiries received by the Survey within the year indicate that though for several years there has been no domestic production, there is some foundation for the belief that the domestic strontium deposits may be worked.

For many years Missouri has supplied the greater part of the crude barytes mined in the United States, but Georgia and Tennessee have produced considerable quantities, and the deposits in Kentucky and Virginia have been more or less productive. Probably the most important reason for the small output from the western deposits is the fact that the market for crude barytes, principally among grinders and makers of lithopone and barium chemicals, is east of the Mississippi and that the largest market is east of the Alleghenies. The freight rates on a commodity of the low value of barytes necessarily determine the deposits that can be worked profitably.

From information received by the Survey it would appear that the barium industry is on a firm foundation, and should continue prosperous under the normal conditions of foreign competition, particularly in the chemical industry. The miners of crude barytes will also feel the return of normal conditions, for prior to 1915 European barytes could be sold to eastern manufacturers cheaper than domestic ore. This was owing largely to the high freight rates from central and southern territory to the markets, which there seems to be small chance of reducing.

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CRUDE BARYTES.

PRODUCTION.

The marketed production of crude barytes in the United States in 1915 was 108,547 short tons, valued at $381,032. This is a notable increase over the production in 1914, which was 52,747 short tons valued at $155,647. The increase was in large part due to the activity of the mines in Georgia, Kentucky, and Tennessee. The Missouri mines, as will be seen from the following table, made an increase of approximately 6,000 tons, but that is much below the increase in Geogia and Tennessee, which amounted to more than 15,000 tons in each State; The increase in Kentucky from a nominal quantity in 1914 to 7,753 tons in 1915 is remarkable. It is interesting to note that Alaska has entered the list of producers of barytes.

It may be well to indicate that the "marketed production" is the total quantity of barytes sold or used by companies which own their own mines. This figure may be greater or less than the actual quantity mined dependent on whether the stocks carried by the mines over a period of years are small or large.

Crude barytes marketed in the United States, 1913–1915.

State.	1913			1914			1915		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
Georgia	(a)	(a)		(a)	(a)		31,027	$102,825	$3.31
Kentucky				(a)	(a)		7,753	28,427	3.67
Missouri	31,131	$117,638	$3.78	33,317	$112,231	$3.37	39,113	158,597	4.05
Tennessee	2,098	3,568	1.70	10,113	16,278	1.61	25,074	71,390	2.85
Other States b	12,069	35,069	2.91	9,317	27,143	2.91	5,580	19,793	3.55
Total	45,298	156,275	3.45	52,747	155,647	2.95	108,547	381,032	3.51

a Included in "Other States."

b Includes, 1913: Georgia, North Carolina, South Carolina, and Virginia; 1914: Alabama, California, Georgia, Kentucky, North Carolina, South Carolina, and Virginia; 1915: Alabama, Alaska, California, North Carolina, South Carolina, and Virginia.

PRICES.

The prices paid for crude barytes in 1915 varied considerably in different States; thus, in Georgia the average price was $3.31 a short ton; in Missouri the price was $4.05 a short ton f. o. b. cars. These prices are higher than in 1914, but the average price did not advance as much as might have been expected, one factor in keeping it down appearing to be the opening of many deposits which have been idle for some time and whose output increased the supply in 1915. It is reported, however, that the demand for crude barytes by the manufacturers of lithopone, ground barytes, and barium chemicals has been very brisk. These augmented uses for domestic material have had a marked influence on prices, and it is understood that there has been a further increase in the price of crude barytes in 1916

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STOCKS.

The apparent stocks of crude barytes held at mines at the end of December, 1915, were 9,676 short tons, 6,500 of which are held in Tennessee, 2,500 tons in Georgia, and the remainder in small quantities in the other producing States. The apparent stocks in 1914 as shown by revised figures, were 11,743 short tons, a large part of which was held in Tennessee.

The term stocks as used by the Survey includes only those stocks held at mine or shipping point, which have not entered the market. It is known that there are considerable stocks of crude barytes held by the lithopone and chemical companies and by grinders, but as these have been purchased or mined and shipped by these companies they are considered as a marketed product in the sense used by the Survey.

IMPORTS.

According to figures compiled from the reports of the Bureau of Foreign and Domestic Commerce, Department of Commerce, 2,504 short tons of unmanufactured barytes were imported in 1915, which from the price given is believed to be crude barytes, though the tariff schedules are not entirely clear on this point. As will be seen from the following table, this is a reduction of approximately 22,000 tons from the imports in 1914, a reduction accounted for by the loss of imports from Germany:

Barytes imported for consumption, 1911–1915.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1911	20,214	$36,643	1914	24,423	$46,782
1912	26,186	52,467	1915	2,504	4,877
1913	35,840	61,409			

CONSUMPTION.

The apparent consumption of crude barytes in 1915 was 111,051 short tons, the sum of the marketed production and imports, which exceeded the apparent consumption of 1914 by 33,881 short tons. Reports received by the Survey indicate that of the marketed production of domestic barytes approximately 50 per cent was used by grinders, 40 per cent by manufacturers of lithopone, and 10 per cent by makers of barium chemicals.

CHARACTER OF BARYTES.

Barytes, the mineral barite (barium sulphate) sometimes called "heavy spar" or "tiff," theoretically is composed of 65.7 per cent of barium oxide (BaO) and 34.3 per cent of sulphur trioxide (SO_3) and has the chemical formula $BaSO_4$. The specific gravity of the mineral ranges from 4.3 to 4.6 and its hardness varies from 2.5 to 3.5. It is commonly found as an aggregate of straight or slightly curved cleavable plates, but it occurs also in granular, fibrous, and earthy masses, and in the form of stalactites. It can be distinguished from calcite

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by its greater weight and by the acid test. Calcite will effervesce with acid but barite will not react.

Most of the crude barytes mined in the United States has some iron in the form of oxides as a coating on joints, faces of crystals, and surface of the lumps. Iron lead, and sinc sulphides, and occasionally copper sulphide are found in the barytes from some localities. Silica, in the form of both quartz and chert, and calcite and flourite are objectionable impurities which are present in some deposits. Commercial crude barytes should carry more than 93 per cent barium sulphate and the better grades of domestic barytes carry at least 95 per cent $BaSO_4$.

In the trade two types of barytes are recognized, "hard crystalline" and "soft." The hard crystalline variety ordinarily has a glassy semitransparent look and can not be broken in the hands. The soft variety, as the name implies, can usually be crumbled, at least the edges of the crystals, by the fingers. The soft variety has a dull milky white color on fresh fractures, is preferred by grinders, and is said to roast better than the hard variety. The hard variety, however, can be made to roast well by a preliminary heating and therefore can be used to better advantage in the lithopone and chemical industries than by the grinders.

All the commercial barytes is graded according to the impurities, particular attention being paid to the content of iron and silica.

MINING AND PREPARATION FOR MARKET.

Until the last few years the mining and preparation of barytes for market has not been conducted in an efficient manner. Most of the productive deposits are of the residual type. The mining is a relatively simple matter and has been done by hand either in open cuts or through shallow shafts. The open cut method would appear to be the most economical and could be used in practically all of the residual deposits with which the writer is acquainted. The ground is broken by picks, the material is shoveled into wheelbarrows or in some places into dump carts, and is hauled out for further treatment.

It has been proposed to mine some deposits by the use of steam shovels, which would undoubtedly handle the barytes-bearing clay in an economical manner; yet there is a factor of considerable importance which should be considered by those contemplating an installation of that character, namely, the spotty nature of most of the deposits. Even in the best deposits there are considerable masses of clay that do not contain barytes. In mining by hand these masses can be left; but the steam shovel would require their removal; and it is therefore doubtful whether this cheap method can be used in a large majority of the mines.

The hydraulic giant would handle these residual clays and could be used to advantage in connection with transportation flumes, log washers, and jigs, all of which would assist in the disintegration and removal of the clay. Unfortunately in the regions where the residual deposits are found the cost of obtaining water under sufficient head to conduct hydraulic mining is prohibitive in view of the low price of the mineral won. In Washington County, Mo., an installation using large steam pumps to obtain head demonstrated the possibility of handling residual barytes deposits by giants, but did not prove commercially successful.

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Where power is cheap or water under sufficient head is available hydraulic mining might well be more thoroughly tested than has yet been done.

Under the system of mining by hand the clay is roughly separated from the barytes in the mines and wheeled to the dump, and the barytes, coated with more or less clay, is thrown out on drying floors where the action of rain and sun disintegrate the clay to some extent.

In some places in Missouri the dried tiff (barytes) is further cleaned in shaking boxes, built somewhat after the manner of a cradle. The barytes is finally hand cobbed to remove chert, clay, galena, sphalerite, and other impurities and is graded according to the cleanness of the resulting material. In this handling, large quantities of finely broken barytes are lost, and can not be recovered by any hand methods.

For some time it has been realized that log washing and jigging would increase the production and yield a cleaner and more valuable product than could be produced by drying and hand cobbing. In 1914 a few washing plants were installed at mines, and in 1915 and 1916 there have been a number of equipments of this sort, particularly in the Eastern States. The water problem again enters with the installation of log washers, but is not usually serious.

At the plants visited by the writer the washers of either the 1 or the 2 log tandem type, are placed near the open cuts where the barytes-bearing clay can after a short haul be dumped through railroad iron grizzleys into the washers. Everything taken from the cut, except the clay that is evidently barren, goes into the washer. From the washer in the better equipped plants the washed barytes goes over a ½-inch mesh trammel, the oversize from which, after hand picking of the chert, goes to the barytes shipping bin. The undersize is fed to 2, 3, or 4 compartment jigs ordinarily of the Hartz type. A clean barytes concentrate is produced, and the tailings show very little loss of barite. It would seem from the success attained in the Georgia and Tennessee fields by the use of log washers and jigs that there need be no further discussion of the desirability of the installation under suitable conditions. In the Missouri field, where the conditions are not the same as in the East in that many independent miners may be working on a single deposit, it would seem that custom plants, perhaps operated by the landowner, might prove to be the solution of the problem.

PRODUCERS.

In the last two years the Survey has had so many inquiries from both producers and consumers of barytes concerning possible markets and sources of supply that it seems advisable to indicate in a general way the present conditions of handling barytes.

In Missouri most of the barytes passes through two and sometimes three hands before it reaches the consumer. The miner sells to a local buyer, most often a storekeeper, in exchange for goods. This buyer sells to a larger buyer having access to the railroad, who in turn sells to one of the larger selling companies or to the consumer. It is next to impossible to deal with the miners or even the first buyers. Often the second buyers are agents for some of the larger purchasing companies and do not deal directly with the consumer. In the

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eastern field conditions are not quite the same. Much of the mining is done by the owners or lessees of the property and the product is sold to large buyers or direct to the consumer. In fact, many deposits in the Eastern States are worked by the consumers themselves, though some of these operators have barytes to sell.

In the following list will be found the names and addresses of the principal people able to supply crude barytes. The addresses given are those of the office of the companies, which are not in all cases at the mines:

J. N. Adams, Del Rio, Tenn.
Anson G. Betts & Co., Box 792, Asheville, N. C.
Big Tom Barytes Co., Cartersville, Ga.
Cahaba Mineral Co., Leeds, Ala.
H. C. Carter & Co., Halifax, Mo.
Carolina Barytes Co., Stackhouse, N. C.
A. H. Carr, Potosi, Mo.
Casey & McGregor, Potosi, Mo.
Cherokee Chemical Co., 109 Hollingsworth Street, Baltimore, Md.
L. E. Cole & Co., Blackwell, Mo.
J. F. Doherty, Sweetwater, Tenn.
Durex Chemical Co., 320 Fifth Avenue, New York, N. Y.
J. C. Finck Mineral & Milling Co., 101 Barton Street, St. Louis, Mo.
B. W. Gahagan, Stackhouse, N. C.
Georgia Peruvian Ocher Co., Cartersville, Ga.
Johnson Bros., Fletcher, Mo.
Krebs Pigment & Chemical Co., Newport, Del.
R. H. Langhorne, Evington, Va.
Chas. L. Lawton, Bessemer City, N. C.
A. Long & Son, Cadet, Mo.
James Long, Potosi, Mo.
McCready & Cole, Blackwell, Mo.
H. J. Moore, Sweetwater, Tenn.
New Riverside Ocher Co., Cartersville, Ga.
Nulsen, Klein & Krausse Manufacturing Co., Levee and Sidney Streets, St. Louis, Mo.
Paga Mining Co., Cartersville, Ga.
Pittsburgh-Potosi Lead Co., 5527 Ellsworth Avenue, Pittsburgh Pa.
Point Milling & Manufacturing Co., Mineral Point, Mo.
Potosi Lead, Barytes & Mercantile Co., 721 Locust Street, St. Louis, Mo.
W. T. Reavis & Sons, Henley, Mo.
South East Missouri Lead Co., Potosi, Mo.
Southern Leasing Co., Cartersville, Ga.
A. & C. Stackhouse, Stackhouse, N. C.
C. A. Stocking & Son, De Soto, Mo.
C. A. Sulzer, Sulzer, Alaska.
A. L. Taylor, Canon City, Colo.
Thompson-Weinman & Co., 100 William Street, New York, N. Y.
U. S. Barytes Co., Tiff, Mo.
Washington Land & Mining Co., 307 Washington Street, St. Louis, Mo.
White & Bro., Cadet, Mo.

GEOLOGY OF THE BARYTES DEPOSITS OF THE UNITED STATES.

GENERAL FEATURES.

Barytes occurs as a gangue mineral in many metalliferous deposits in the United States, but has not been saved, so far as the Survey is aware, as a commercial product when found associated with metallic ores. Some commercial deposits of barytes have the form of veins in sandstones, limestones, or crystalline rocks, and a few deposits of the replacement type have been worked. The greater part of the barytes produced in the United States is mined from residual clays

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which are derived from the weathering of rocks that contained the mineral. By far the largest number of these deposits are in clays derived from the weathering of magnesian limestones (dolomite) of Cambrian and Ordovician age; some are in clays derived from the breaking down of pre-Cambrian crystalline rocks; and in a few places residual deposits derived from Carboniferous rocks have been worked.

The barytes in the residual deposits was originally in veins or replacements in the hard rocks whose disintegration products are left. Owing to the slight solubility of the barite and the silica (quartz and chert), these minerals resisted the agencies of weathering and were left behind with the clay upon the removal of the soluble constituents of the original formations.

There is little question that the original deposits were formed by precipitation from aqueous solutions. Some deposits, particularly those associated with metallic ores, were evidently derived from heated waters, but other deposits were as evidently deposited by cold waters. The distribution of the barite in the original rocks seems to have been influenced largely by the presence of openings through which solutions carrying barium could penetrate. Thus, in Alabama, Georgia, Tennessee, central Kentucky, and Virginia the barytes deposits are located along or near zones of folding and faulting of the late Cambrian and early Ordovician rocks. In Missouri, fracturing of the Cambrian rocks is conspicuous, and in western Kentucky the Carboniferous strata, in which the fluorite-barite veins are found, are faulted to a considerable degree.

The present distribution of workable residual deposits seems to have been determined largely by the distribution of the barytes in the original formations, but in part is due to other causes. In the Georgia field the principal deposits are located along and quite near the contact of Weisner quartzite and Beaver limestone, and it would appear that the barite originally replaced one of the lower beds of the Weisner. Gravitational creep down the slopes has caused a rough separation of limonite and barite and has influenced the locations of the workable deposits. In the Missouri field it is said that there is rather marked concentration of barite at the lower limit of frost action, and certainly in some localities concentration by gravitational creep is evident.

In the following pages will be found a brief summary of the deposits of barytes in the United States and Alaska. There is little new material presented; rather the information scattered through various technical journals and reports of the State and Federal geological surveys is here brought together as being of interest to the public. As will be noticed, individual reference to the various papers is not always given; the information has been taken from the papers listed under each State and from notes by members of the Survey.

The map (Pl. I) shows the location of the deposits now worked and of some, not yet worked, which are believed to have possibilities of commercial development. It also shows the location of what are believed to be the most promising deposits of strontium-bearing ores from the commercial standpoint. The approximate locations of the barium-products works is given as being of interest in showing the relative commercial importance of the barium deposits based on distance from markets.

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ALABAMA.

Alabama again entered the list of producers of barytes in 1915. One deposit in Calhoun County was worked and it is authoritatively reported that a deposit near Leeds, Jefferson County, will be exploited during 1916. The 1915 output was sold to manufacturers of lithopone.

The commercial barytes deposits of Alabama [1] are of the residual type; most of the better-known deposits are located in the central and northeastern part of the State, including Bibb, Calhoun, Etowah, Jefferson, Shelby, and St. Clair counties. Lower Paleozoic rocks underlie parts of all these counties and the Knox dolomite (of Cambrian and Ordovician age) and the Chickamauga limestone (of Ordovician age) outcrop in them. These formations, from which the barite is derived, outcrop in narrow northeastward-trending bands, whose position is determined by the folding and faulting that formed the Appalachian Mountains. The more important deposits are near the contact of the two formations, though some deposits are found in residual clays derived entirely from the Knox dolomite. It is said that barite-bearing veins are found in the dolomite and limestone. Alabama barite is of good quality, usually pure and white, but sometimes colored and iron-stained. The barite from some localities is associated with galena. The principal cause of the lack of development of these deposits in the past appears to have been the distance to grinding mills and other consumers.

ARIZONA.

Barite-bearing veins in basalt and sandstone were found by E. L. Jones, of the United States Geological Survey, in 1914, at the north end of the Whipple Mountains in the Colorado Indian Reservation, about 10 miles from Parker, Yuma County, Ariz. The veins are small, as a rule, though some of them attain a width of 3 feet and are traceable for 100 feet on the surface. Calcite is found in some of the veins with the barytes, but the best barytes seems to occur in the smaller veins, which are in sandstone. Iron-stained barytes mixed with more or less iron and manganese oxides is found at a number of places in the State. These occurrences are as a rule associated with metallic ore deposits and the barite can not be considered to have any commercial value.

ALASKA.

In 1915 the first shipment of barytes was made from Alaska. This was shipped to the Pacific coast for experimental purposes. Mr. Sulzer, owner of the deposit, reports that he will install a grinding plant at Lime Point and that he expects to market ground and floated barytes in 1916. So far as the Survey can learn this will be the only commercial barytes grinding plant on the Pacific coast.

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[1] Butts, Charles, U. S. Geol. Survey Geol. Atlas, Birmingham folio (No. 175), 1910.
Grasty, J. S., Mineral resources of the South; Barite deposits of Alabama: The Tradesman, July 13, 1913, pp. 35-36.
Hayes, C. W., U. S. Geol. Survey Geol. Atlas, Gadsden folio (No. 35), 1896.
Smith, E. A., Report of progress for 1875, p. 95, Alabama Geol. Survey, 1876.
Smith, E. A., and McCalley, Henry, Index of the mineral resources of Alabama, pp. 62-63, Alabama Geol. Survey, 1904.
Watson, T. L., and Grasty, J. S., Barite of the Appalachian States: Am. Inst. Min. Eng. Bull. 98, pp. 351-353, February, 1915.

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THEASTERN ALASK

Showing orks manufacturing barium

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This deposit was examined by Theodore Chapin,[1] of the United States Geological Survey, in 1915, who reports as follows:

A deposit of barite recently discovered in the Kétchikan district is now being exploited. It occurs on Lime Point, the southern end of the peninsula between Hetta and Nutkwa inlets on the west coast of Prince of Wales Island. The country rock is semicrystalline, blue-weathering, white limestone interbedded with talc schist. The limestone has a general northerly strike and dips about 80° W. An opening has been made along the deposit for 100 feet, exposing a body of barite about 30 feet wide. It is roughly tabular in shape and stands nearly vertical, conforming to the bedding of the inclosing limestone. The barite appears to be a replacement of the limestone. It is a finely crystalline white rock containing practically no visible impurities.

Samples collected by Chapin are of exceptionally white, fine-grained crystalline barite, which appears to be well suited for grinding. An analysis made by the Survey gave the following results:

Analysis of barite from Lime Point, Alaska.

[George Steiger, analyst.]

SiO_2	0.42
Al_2O_3, Fe_2O_3, FeO	.12
MgO	.16
CaO	None.
SO^3	34.01
BaO	64.94
SrO	None.
	99.84

Another deposit on Castle Island in the Duncan Canal, 40 miles northwest of Wrangell, southeastern Alaska, was described by Burchard.[2]

The deposit of barite forms a rock mass about 200 feet long that stands 35 feet above high tide and is 75 feet wide. A rough calculation indicates that there should be more than 50,000 tons of barite available above high-tide level. The barite is very much jointed and fractured. The beds strike N. 30° W. and dip steeply northeast. On the southwest side of the body a granular schistose rock is visible. The barite is finely crystalline grayish white, but is seamed with thin blue veins and clouded areas and a few thin black streaks. Some white quartz is present in the streaks and pyrite is nearly everywhere present in seams and segregations. The dark seams are composed of minerals, among which are probably galena, sphalerite, magnetite, and graphite.

Analysis of barite from the vicinity of Wrangell, Alaska.

[W. C. Wheeler, analyst.]

	Original.	Recalculated.
Silica	5.05	5.05
Iron oxide	.77	.77
Titanium oxide	None.	None.
Calcium oxide	Trace.	Trace.
Magnesium oxide	Trace.	Trace.
Barium oxide	58.60	58.60
Strontium oxide	.37	.37
Sulphur trioxide	34.74	33.69
Carbon dioxide	None.	None.
Lead oxide	.15	.....
Lead sulphide	.....	.16
Zinc sulphide	.....	1.68
Manganese dioxide	Trace.	Trace.
	99.68	100.32

[1] Chapin, Theodore, and Canfield, G. H., Mining developments and water-power investigations in southern Alaska: U. S. Geol. Survey Bull. 642-B (in press).

[2] Burchard, E. F., A barite deposit near Wrangell: U. S. Geol. Survey Bull. 592, pp. 109–117, 1914.

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So far as the Survey can learn, no barytes was shipped from this deposit in 1915. Purington [1] reported that a large quantity of barytes pebbles was found in the placer sluice boxes on American Creek, which enters Mission Creek near its junction with Yukon River near Eagle.

CALIFORNIA.

The barite-witherite veins near El Portal, Mariposa County, Cal., were operated in 1915 by the Barbour Chemical Co., the output being shipped to the company's chemical works at Melrose. The veins are in slates not far removed from the granodiorite contact. It is said that at the surface barite is found alone, but at a shallow depth witherite is associated with the barite, and that in the lower workings the vein is nearly pure witherite, carrying a little pyrite.

A deposit of barytes in the San Dimas Canyon, Los Angeles County, was developed in 1915, but none of the mineral was shipped. Deposits of barite are also known in Butte and San Bernardino counties.[2]

COLORADO.

Though no barytes mined in Colorado was marketed in 1915, a vein said to occur in granite has been opened on Oak Creek in Custer County. The development of this deposit should be of interest inasmuch as zinc oxide, which it is understood is not sold as pigment, is produced at Leadville. With cheap zinc and barytes the possibilities of a lithopone plant located anywhere along the Denver & Rio Grande Railroad seems worthy of consideration. It is also understood that at least two Denver companies will engage in the manufacture of barium chemicals.

Barite is known as a gangue mineral at Leadville and Aspen, and in Pitkin and San Juan counties, but so far as known no commercially important bodies of barite have been discovered in any of the metal-mining camps. This may be due more to the fact that prospecting was directed toward the discovery of metals rather than of nonmetals, and also because of the high freight rates, which would naturally prevent the exploitation of a product with as low a value as barytes.

CONNECTICUT.

Some years ago barytes deposits in Connecticut were mined, but of late the records of the Survey indicate that none of the mineral has been produced in the State. The barytes occurs [3] in veins in the Triassic sandstones of the Connecticut River valley in close association with trap dikes. The principal locality in which mining was done is in Cheshire, 10 to 12 miles north of New Haven. In this locality lenslike veins from 2 to 4 feet wide, consisting of nearly pure barite with a little galena and chalcopyrite, are found both parallel to and cutting the bedding of the sandstone.

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[1] Purington, C. W., Methods and costs of gravel and placer mining in Alaska: U. S. Geol. Survey Bull. 263, p. 204, 1903.

[2] Aubury, L. E., The structural and industrial materials of California: California State Min. Bur. Bull. 38, p. 264, 1906.

[3] Bowen, G. T., Am. Jour. Sci., 1st ser., vol. 4, p. 327, 1881.

Percival, J. A., Notice of the locality of sulphate of barytes, from which a specimen was analyzed by G. T. Bowen, and of various other mine localities in Berlin, Conn.: Idem, vol. 5, pp. 42-45, 1882.

Rice, W. N., and Gregory, H. E., Manual of the geology of Connecticut: Connecticut Geol. and Nat. Hist. Survey Bull. 8, p. 196, 1906.

Sheppard, J. A., Report on the geology of the State of Connecticut, p. 437, New Haven, 1842.

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It is said that farther north, extending into Massachusetts, small discontinuous veinlike bodies of barytes are found in the pre-Cambrian schists and gneisses.

GEORGIA.

In 1915 there was marketed from deposits in the vicinity of Cartersville, Bartow County, Ga., 31,027 short tons of barytes, which was about six times the output of 1914. This great increase was made largely by the operations of new companies, six operators reporting sales in 1915 against two in 1914. It is understood that there are at least eight companies operating in 1916 in this district. Most of the output in 1915, which was 29 per cent of the total for the United States, appears to have been sold to makers of lithopone, though some was sold to grinders and some to the chemical industry.

The principal barite deposits of Georgia [1] are in the vicinity of Cartersville, Bartow County, though formerly some high-grade barytes was mined near Elton, in Murray County. In the Cartersville region the barite deposits are closely associated with the Weisner quartzite and the overlying Beaver limestone, which are the two lower formations of the Cambrian rocks. The Weisner quartzite, from 2,000 to 3,000 feet thick, is a fine-grained quartzite containing some beds of fine conglomerate. The formation is intensely folded and faulted, and as a consequence its open brecciated condition has been favorable to the deposition of minerals, the chief of which are iron ore, ocher, and barite. The Beaver limestone, 800 to 1,200 feet thick, is a gray crystalline magnesian limestone, shaly in places and chert-bearing. As the limestone weathers rapidly to a red clay, few outcrops of the Beaver are seen. The barite is found with ocher in fractures and cavities in the Weisner quartzite, and as masses and nodules embedded in the residual clays derived from the weathering of both the Weisner and the Beaver formations. The residual deposits are the more important commercially. The principal deposits of the residual type so far worked are east of Cartersville, on both sides of Etowah River. In this region the quartzite belt has a distinct anticlinal structure. Along the eastern side of this anticline, where the chief deposits are located, the beds dip 45° E.

In general, bodies of iron ore rest directly on the quartzite at the contact with the overlying Beaver limestone. Down the slope, but parallel to the contact, are found the bodies of residual barite. There is a sharply defined line between the bodies of residual barite and of limonite. It seems probable that the two minerals have replaced distinct beds of the shaly limestone overlying the quartzite and that

[1] Hayes, C. W., Geological relations of the iron-ore deposits in the Cartersville district, Georgia: Am. Inst. Min. Eng. Trans., vol. 30, pp. 403–419, 1900.
Hays, C. W., and Phalen, W. C., A commercial occurrence of barite near Cartersville, Ga.: U. S. Geol. Survey Bull. 340, pp. 458–462, 1908.
Maynard, T. P., A report on the limestones and cement materials of north Georgia: Georgia Geol. Survey Bull. 27, p. 293, 1912.
McCallie, S. W., A preliminary report on a part of the iron ores of Georgia: Georgia Geol. Survey Bull. 10-A, pp. 103–176, 1900.
Spencer, J. W., The Paleozoic group, pp. 99–107, Georgia Geol. Survey, 1893.
Watson, T. L., Geological relations of the manganese ore deposits of Georgia: Am. Inst. Min. Eng. Trans., vol. 34, pp. 207–253, 1903; A preliminary report on the manganese deposits of Georgia: Georgia Geol. Survey Bull. 14, pp. 32–99, 1908; The yellow ocher deposits of the Cartersville district, Bartow County, Ga.: Am. Inst. Min. Eng. Trans., vol. 34, pp. 643–666, 1903; A preliminary report on the ocher deposits of Georgia: Georgia Geol. Survey Bull. 13, 1906.
Watson, T. L., and Grasty, J. S., The geology and barite deposits of the Cartersville, Ga., district: The Tradesman, May 22, 1910, pp. 35–37; Barite of the Appalachian States: Am. Inst. Min. Eng. Bull. 98, pp. 345–411, February, 1915.

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their present position is largely determined by the specific gravity of the minerals. In the barytes-bearing residual clay the barite is said to constitute about one-third of the material.

IDAHO.

Barite is known to occur as a gangue mineral in a number of the metal-mining districts of Idaho, notably in the Coeur d'Alene and at Silver City, but it is not separated. A deposit found by L. G. Westgate, of the United States Geological Survey, near Hailey, Custer County, would appear to have commercial possibilities. The deposit is located at the head of Deer Creek, about 9 miles west-northwest of Hailey and about 7 miles west of the railroad at the mouth of Deer Creek. It is said to be a lenslike mass 50 feet thick by 1,000 feet long, lying apparently conformably with the Pennsylvanian quartzites and calcareous sandstones of the region, which strike N. 50° W. and dip 55° NE. It outcrops 1,400 feet above Deer Creek Valley at an altitude of 7,400 feet. The whole body is composed of white, finely crystalline barytes marked with brownish bands.

KENTUCKY.

In 1915 there were 7,753 short tons of barytes marketed in Kentucky, largely from deposits in the central part of the State, though two mines in the western part were producers. Deposits in Woodford County produced 3,262 tons, and in Jessamine and Lincoln counties, 2,893 tons. The remainder of the output came from deposits in Bourbon, Crittenden, Fayette, Scott, and Garrard counties. The greater part of the output in 1915 was sold to manufacturers of barium chemicals.

The barite deposits of Kentucky[1] are found in the central or "Blue Grass" region, and in the counties of western Kentucky lying immediately east of Tennessee River.

In 19 counties centered about Lexington there are veins of barytes lying along or near zones of faulting having a predominant northward trend. These faults are approximately parallel to the major axis of the Cincinnati arch and are closely related in age to the folding. Normal faulting of several hundred feet displacement and horizontal or slip faulting parallel to the strike of the vein of a few feet throw, have taken place. The faults are marked by brecciated zones. The rocks involved range from Lower Ordovician (Stones River) to Mississippian in age. In the barytes-producing areas the earlier Ordovician rocks, including the Lexington (early Middle Ordovician) and Stones River formations, are most important. The veins are found in the brecciated fault zones and are larger and more productive in the limestone members than in the shale members. They

[1] Fohs, F. S., Fluorspar deposits of Kentucky, with notes on the production, mining, and technology of the mineral in the United States; also some data concerning barite deposits: Kentucky Geol. Survey Bull. 9, pp. 24, 25, 27–30, 1907; The barytes and associated deposits of central Kentucky: Kentucky Geol. Survey Rept. Progress, 1908–9, pp. 94–99, 1910; Barytes deposits of Kentucky: Kentucky Geol. Survey, 4th ser., vol. 1, pt. 1, pp. 441–588, 1913.

Grasty, J. S., The barite deposits of Kentucky: The Tradesman, July 3, 1913, pp. 33, 34.

Miller, A. M., The lead and zinc bearing rocks of central Kentucky, with notes on the mineral vein: Kentucky Geol. Survey Bull. 2, 1905.

Ulrich, E. O., and Smith, W. S. T., Lead, zinc, and fluorspar deposits of western Kentucky: U. S. Geol. Survey Bull. 213, pp. 205–213, 1913; U. S. Geol. Survey Prof. Paper 36, 1905.

Watson, T. L., and Grasty, J. S., Barite deposits of the Appalachian States: Am. Inst. Min. Eng. Bull., 98, pp. 357–361, February, 1915.

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are nearly vertical, irregular in width, averaging 2 to 4 feet wide and attaining a maximum width of 16 feet. Simple veins are rare; most of the deposits occur in fault zones but assume rather the vein form than the replacement form, though replacement deposits are known, particularly in beds of coarsely crystalline limestone. Where mineralization of a breccia occurred, calcite and fluorite were more apt to be deposited than barite, which usually occurs in the more open fissures. Calcite, fluorite, galena, sphalerite, and pyrite occur in greater or less abundance throughout these veins, but masses of pure barite are common. Most of the barite is finely crystalline, occurring as granular masses rather than as aggregates of large well-developed crystals. Strontium sulphate is often associated with the barytes, occurring both as encrustations and also intimately mixed with the barium sulphate. The following analyses are said to represent samples of typical Kentucky barytes:

Analyses of barytes from Kentucky.[a]

	1	2	3	4	5	6	7	8	9	10	11
Ignition (moisture, carbon dioxide, hydrocarbons)	0.17	0.34	0.87	0.28	0.62	0.23	1.40	0.65	0.15	1.19	0.28
Silica	.34	.11	.11	.25	.10	.05	.55	.18	.10	.20	.23
Iron oxide	.06	.62	.04	.06	.06	.03	.06	Trace.	.04	.08	Trace.
Barium oxide	50.86	50.96	60.26	64.72	59.80	50.96	54.95	10.71	64.68	49.98	60.55
Strontium oxide	8.99	11.65	3.80	Trace.	2.41	11.10	6.75	45.06	.20	11.07	3.72
Calcium oxide	3.61	Trace.	.76	Trace.	2.09	.88	.20	.25	Trace.	Trace.	Trace.
Sulphur trioxide	33.87	36.31	34.60	33.82	33.23	35.66	34.22	42.28	33.97	35.12	35.38
Fluorine	2.45	Trace.	.52	.00	1.42	.60	.14	.00	.00	.50	.00
Zinc oxide	Trace.	.00	.00	.00	.00	.00	1.23	.00	.00	1.50	.00
	100.35	99.39	100.96	99.13	99.73	99.51	99.50	99.13	99.14	99.68	100.16

[a] Kentucky Geol. Survey, 4th ser., vol. 1, pt. 1, pp. 449–451.
1. John Baughman prospect, one-half mile north of Danville, Boyle County, white and gray banded barytes with calcite.
2. Lee River prospect, one-half mile south of Harrodsburg, Mercer County, cream-colored arborescent barytes.
3. Farris prospect, 4 miles northeast of Danville, Boyle County, fibrous white barytes.
4. Meyers prospect, near Mexico, Crittenden County, pure white barytes; some iron stain.
5, 6. Ray mine, 2 miles from Fredonia, Caldwell County, 5, soft white fibrous barytes; 6, hard fine granular barytes.
7. Haydan open cut, 1½ miles south of Danville, Boyle County, impure altered barytes.
8. Truesdale, Owen County, celestite.
9. Perkins prospect, 1½ miles southeast of Burgin, Mercer County, dark-gray barytes.
10. Mosly prospect, 1½ miles south of Shyrock ferry, Woodford County, arborescent creamy barytes; contains some copper.
11. Shelton open cut, 4 miles east of Danville, Boyle County, white lamellar barytes.

In western Kentucky workable bodies of barite are found in some of the veins that are worked for fluorite. The veins occur in limestones, sandstones, and shales of Carboniferous age, which have been fractured, faulted, and intruded by basic igneous rocks in the form of dikes. The principal faulting and fracturing is along northeast and northwest lines. The mineral-bearing zones seem to follow the northeast line, and individual bodies of fluorite and barite are usually not continuous over great distances; rather the ore bodies are arranged in echelon. Fluorite, barite, calcite, galena, and sphalerite are the most widely distributed minerals. They occur both in veins and as replacements of the wall rocks, particularly in brecciated zones or beds. Ordinarily the minerals are more or less intergrown but banding is common, and rarely are deposits of one mineral found.

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MARYLAND.

Mayland, so far as the Survey records show, has not been a producer of barytes for many years. Barytes deposits are known in Frederick and Carroll counties and have been reported in the Hagerstown valley.[1] The more important deposits are located in the Piedmont region and are associated with limestones and quartzites doubtfully correlated with the Cambrian Weverton and Loudoun formations, which have been intensely faulted and crushed. The barite occurs in small bands or strings but presumably can be hand sorted from calcite and rock.

MISSOURI.

During 1915 there was marketed 39,113 short tons of barytes from mines in Missouri, an increase of 5,796 tons over the production in 1914. Washington County produced approximately 90 per cent and St. Francois 6 per cent of the total, and the remainder was from mines in Jefferson, Miller, and Cole counties, as shown by the following table:

Barytes marketed in Missouri in 1915.

County.	Quantity (short tons).	Value.
Jefferson	1,347	5,962
Miller and Cole	404	1,695
St. Francois	2,388	10,123
Washington	34,974	140,817

Missouri still holds first rank as a producer of barytes, but whereas in 1914 her mines produced 63 per cent of the total for the United States, in 1915 the State produced only 36 per cent of the total. Apparently a large part of the Missouri barytes was sold as ground product, but some crude barytes was sold to makers of lithopone and to barium chemical plants.

The principal barytes deposits of Missouri[2] are found in Washington, St. Francois, and Jefferson counties in southeastern Missouri and in Cole, Miller, Moniteau, and Morgan counties in the central part of the State.

The largest number of deposits that have been worked are in northeastern Washington County, located between the Iron Mountain Railroad and Mineral Fork River. Tiff, Cadet, Mineral Point, and Potosi are the principal shipping points. The Gasconade and the

[1] Grasty, J. S., The barite deposits of Maryland give promise of becoming important: Min. and Eng. World, Dec. 19, 1914, p. 1137.
Watson, T. L., and Grasty, J. S., Barite of the Appalachian States: Am. Inst. Min. Eng. Bull. 98, pp. 361–363, February, 1915.

[2] Ball, S. H., and Smith, A. F., Geology of Miller County, Mo.: Missouri Bur. Geology and Mines, 2d ser., vol. 1, pp. 42, 60, 76, 106, 148, 149, 175, 1903.
Buckley, E. R., Geology of the disseminated lead deposits of St. Francois and Washington counties: Missouri Bur. Geology and Mines, vol. 9, pt. 1, pp. 224–248, 1909.
Hughes, V. H., Reconnaissance work: Missouri Bur. Geology and Mines Rept. State Geologist, 1910, pp. 36–54, 1911.
Marbut, E. F., The geology of Morgan County: Missouri Bur. Geology and Mines, 2d ser., vol. 7, pp. 86–87, 1907.
Steel, A. A., The geology, mining, and preparation of barite in Washington County, Mo.: Am. Inst. Min. Eng. Trans., vol. 40, pp. 85–117, 1910.
Van Horn, F. B., and Buckley, E. R., The geology of Moniteau County, Mo.: Missouri Bur. Geology and Mines, 2d ser., vol. 3, pp. 30, 48, 55, 63, 76, 82, 1906.
Wittich, L. L., Barytes in Missouri: Mines and Minerals, vol. 33, pp. 95–97, 1912.

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Potosi formations of Cambrian age underlie practically the whole of this vicinity. These formations are largely dolomitic cherty limestones which have been extensively weathered and have left a red residual clay that is 40 feet deep in many places. The barytes (or "tiff," as it is locally called), is mined from the residual deposits. It is associated with chert, and in some deposits considerable galena is found with the barite. The barite apparently originated as the filling of shattered zones of dolomitic limestone, of solution caves, and of fissures. Some of these openings were first filled with silica both as chert and quartz, followed in some places by a thin deposit of galena and next by white, platy barite with which there is some galena. After the first deposition some of the openings were shattered; then there was a deposition of dolomite and calcite in them which was followed by marcasite, and lastly by barite. The weathering of these lode deposits has formed the residual bodies that are now the largest source of the mineral in Washington County. Some barytes lodes could doubtless be mined and a few have been opened. In most of the residual deposits the barytes is somewhat concentrated 2 to 6 feet below the surface, above which there is little of the mineral, though chert and flint may be present; below this concentrated zone the barytes is unevenly scattered through the clay. It would seem that the limit of concentration may be the limit of disturbance from freeze and thaw.

The Washington County barite from the top of the residual deposits is quite soft and carries considerable limonite on joints and crystal faces; that from the lower parts of the deposits near bed rock is usually harder and is iron-stained only on the surface of the lumps. No published analyses of Missouri barytes are available.

The barytes deposits of central Missouri are quite similar to those of the eastern part of the State, but they have not been so extensively developed. The residual deposits are said to result from the decomposition of Gasconade (Cambrian), Jefferson City (Ordovician), and Burlington (Mississippian) formations; the chief deposits are derived from the Gasconade. Lead, zinc, and copper sulphides and calcite and chert are apparently more abundant throughout these deposits than in those in Washington County, but bodies of nearly pure barite are not uncommon.

MONTANA.

So far as known to the Survey the only deposit of barite of possible commercial grade in Montana is located in Pattee Creek about 2 miles southwest of Missoula.[1] At this place a 2 to 3 foot vein striking east consists of nearly pure white barytes.

Nodules consisting of nearly pure barytes have been found at widely scattered localities along the outcrop of the Fox Hills (Cretaceous) sandstone in eastern Montana.

NEVADA.

Barite occurs as a gangue mineral in many of the mining districts of Nevada, but is not believed to have commercial possibilities in these deposits. Veins of nearly pure barite have been found in the

[1] Rowe, J. P., Barytes deposits in Montana: Min. World, vol. 28, p. 637, 1908; Some economic geology of Montana: Montana Univ. Bull. 50, 1908.

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vicinity of Ely and Cherry creeks, White Pine County; near Luning and Hawthorne, Mineral County; and at Goodsprings, Clark County. In 1910 it was reported [1] that barite was being shipped from Lone Mountain near Blair, 15 miles west of Tonopah. Apparently the same deposits were reopened during 1915,[2] though the Survey has not been able to confirm the newspaper reports concerning the activiy of these deposits. Spurr [3] does not mention barite as a constituent of the lead, silver, or copper ores of the Lone Mountain district, which occur in Paleozoic sedimentary rocks, mostly limestones, dolomite, and shale, that have been intruded by granite.

NORTH CAROLINA.

The production of barytes in North Carolina in 1915 was slightly less than in 1914. As there were only two shippers of barytes from the State in 1915, figures of output can not be disclosed. Most of the operating mines are in the vicinity of Stackhouse, Madison County. It is reported that the mines near Bessemer City, Gaston County, are under development and that a new body of barytes has been opened. So far as can be ascertained the output in 1915 was consumed in the manufacture of lithopone.

The barite deposits [4] are associated with pre-Cambrian granites or schists. On the Kings Mountain Ridge, which runs in a south-southwesterly direction from Bessemer City for several miles, there are a number of openings on lenticular veins of barite, which are closely associated with sericitic schists. The principal mine is the Lawton, 5 miles south of Bessemer City, at the north end of the ridge. Most of the barite-bearing veins are east of the highest part of the ridge and lie parallel to the schistosity of the inclosing rocks. The barite is granular and is associated with quartz, galena, and sphalerite.

The Madison County barite belt is about 5 miles long; it extends from Bluff, on Spring Creek, in a northeast direction through Doe Run and crosses French Broad River near Sandy. In this belt, which is close to a large thrust fault, are infolded remnants of Cambrian quartzite (Snowbird formation) in the Archean granite, which is the general county rock. The barite occurs in narrow irregular veins in the granite, particularly near the contact with the quartzite and to a less extent in the quartzite. There is said to be very little impurity in the Stackhouse barite. The mine openings are mostly well above the streams and it would seem that there is a considerable reserve of the mineral in these deposits.

PENNSYLVANIA.

The barite deposits [5] of Pennsylvania have not been worked for several years. In the vicinity of Waynesboro and Chambersburg

[1] Daily Min. Rec., Denver, Nov. 19, 1910.
[2] Goldfield producing war metals: Daily Min. and Financial Rec., Denver, Jan. 18, 1916.
[3] Spurr, J. E., Ore deposits of the Silver Peak quadrangle, Nevada: U. S. Geol. Survey Prof. Paper 55, pp. 75–83, 120–121, 1906.
[4] Judd, E. K., The barytes industry of the South: Eng. and Min. Jour., vol. 83, pp. 751–752, 1907.
Keith, Arthur, U. S. Geol. Survey, Geol. Atlas, Asheville folio (No. 116), p. 9, 1904.
Pratt, J. H., North Carolina Geol. Survey Econ. Paper 6, pp. 62-65, 1902.
Pratt, J. H., and Berry, H. M., The mining industry in North Carolina during 1908–9–10, North Carolina Geol. and Econ. Survey Econ. Paper 23, p. 134, 1911.
Watson, T. L., and Grasty, J. S., Barite of the Appalachian States: Am. Inst. Min. Eng. Bull. 98, pp. 363–365, February, 1915.
[5] Stose, G. W., Barite in southern Pennsylvania: U. S. Geol. Survey Bull. 225, pp. 515–516, 1904; U. S. Geol. Survey Geol. Atlas, Mercersburg-Chambersburg folio (No. 170), p. 18, 1909.
Watson, T. L., and Grasty, J. S., Barite of the Appalachian States: Am. Inst. Min. Eng. Bull. 98, pp. 365–366, February, 1915.

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barite has been mined from residual clays derived from the weathering of folded and shattered Cambrian rocks. It also occurs in small quantities near New Hope, Butler County, and in Chester, Fulton, and Montgomery counties. Samples of barite from the Waynesboro locality carry 89.65 to 95.91 per cent barium sulphate.

SOUTH CAROLINA.

The mines at Kings Creek, Cherokee County, S. C., operated by the Cherokee Chemical Co., were productive during 1915, but they were the only producers in the State during the year. The figures of output can not be disclosed. The material was sold in ground form.

The only commercial deposit of barytes in South Carolina concerning which the Survey has information is at Kings Creek, Cherokee County. This deposit is on the strike of the deposits in North Carolina on the Kings Mountain Ridge. The deposits [1] occur with sericitic schists and are in the form of lenticular veins approximately parallel to the folded structure. Interlacing and cross veinlets are seen. The veins attain a maximum width of 8 feet but average about 18 inches. Deposits on each side of the Southern Railway tracks have been opened by cuts, and it would appear that a considerable quantity of barytes could be easily mined at this locality. The barite is granular, white to rose-pink in color, and contains some quartz and a little galena, which are ordinarily found in seams and veins but in some places are distributed throughout the barytes. An analysis of this baryte, made by Ricketts and Banks, shows $BaSO_4$, 93.59; Fe_2O_4, 0.32; CaO, 0.02; MgO, trace; SiO_2, 4.76.

Several prospects on similar barytes deposits were seen by the writer near the North Carolina line about midway between Kings Creek and Kings Mountain. The veins that were opened were lenticular, not very large, and, owing to the long haul to a railroad, did not appear to be of present commercial value.

TENNESSEE.

The marketed production of barytes from Tennessee was 25,074 short tons in 1915, an increase of about 150 per cent over 1914. The mines of McMinn, Monroe, and Loudon counties were most productive, there being a particularly notable increase from the McMinn County mines. Most of the barytes mined in this State in 1915 was used in the manufacture of chemicals, though some was sold to lithopone makers.

The commercially important barytes deposits of Tennessee [2] are located in the Sweetwater district, which covers parts of McMinn,

[1] Sloan, Earl, Catalogue of the mineral localities of South Carolina: South Carolina Geol. Survey, 4th ser., Bull. 2, pp. 125–126, 1908.
Watkins, J. H., Barytes at Kings Creek, S. C.: Eng. and Min. Jour., vol. 99, pp. 1074–1075, 1915.
Watson, T. L., and Grasty, J. S., Barite of the Appalachian States: Am. Inst. Min. Eng. Bull. 98, pp. 367–368, February, 1915.

[2] Fay, A. H., Barytes in Tennessee: Eng. and Min. Jour., vol. 87, p. 137, 1909.
Grasty, J. S., The barite deposits of Tennessee: The Tradesman, May 1, 1913, pp. 34–38.
Hayes, C. W., U. S. Geol. Survey Geol. Atlas, Cleveland folio (No. 20), 1895; Kingston folio (No. 4), 1894.
Henegar, H. B., Barite deposits in the Sweetwater district: The Resources of Tennessee, vol. 2, pt. 11, pp. 424–429, Tennessee Geol. Survey, 1912.
Herzey, C. S., Tennessee barytes: Mineral Industry, vol. 10, p. 58, 1901.
Judd, E. K., The barytes industry of the South: Eng. and Min. Jour., vol. 83, pp. 751–752, 1907.
Keith, Arthur, U. S. Geol. Survey Geol. Atlas, Loudon folio (No. 25), 1896.
Watson, T. L., Fluorite and barite in Tennessee: Am. Inst. Min. Eng. Trans., vol. 37, p. 890, 1907.
Watson, T. L., and Grasty, J. S., Barite of the Appalachian States: Am. Inst. Min. Eng. Bull. 98, pp. 369–374, February, 1915.
Weller, C. A., Barytes mines of the Commercial Mining & Milling Co.: Eng. and Min. Jour., vol. 83, p. 851, 1907.

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Monroe, and Loudon counties. In this region northeastward trending ridges of Cambrian, Ordovician, and Silurian rocks are the pronounced features. The rocks are much folded, and faulting of the thrust type has further complicated the structure. The barytes deposits are of the residual type, the mineral being found principally in the clays derived from the weathering of the Knox dolomite of Cambrian and Ordovician age. The residual clays may be 60 feet thick but average between 10 and 20 feet. The deposits are worked largely by open cuts on the sides or tops of hills, and few cuts have reached the underlying limestone formations. Much of the barytes mined in this district is of the hard, crystalline variety, but some is soft. Most of it is somewhat iron-stained and in some of the deposits the surface of the lumps of barite is coated with one-sixteenth to one-eighth inch of hard limonite. Chert, some of which at first glance closely resembles barite, is abundant in all the deposits but presents no difficulty in removal. Analyses of typical samples published first by Grasty[1] are given below:

Analysis of barytes from Tennessee.

	Roy property.	Terry property.
$BaSO_4$	97.56	94.12
Fe_2O_3	.42	.70
SiO_2	.41	2.45

The French Broad district of Cocke and Sevier counties, on the North Carolina State line, has not been extensively developed, as it has limited transportation facilities. The center of the district is about 40 miles east southeast of Knoxville. In this district veins of barite from 1 to 6 feet wide occur in the Cambrian Cochran conglomerate. They are said to be similar to the veins worked near Stackhouse, N. C., and to carry almost no impurities.

Barytes occurs in other localities in the State, but in these places is not believed to be commercially important.

UTAH.

There are veins of crystalline barytes of good grade at several places in the Wasatch Mountains. In the Argenta district, 10 miles north of Peterson on the Union Pacific, there is, according to Loughlin,[2] a bedded replacement of Cambrian limestone, which consists of barite, with some sulphides of lead and iron. Veins of barite and fluorite with varying quantities of sulphides are known in the pre-Cambrian granite gneiss of the west front of the Wasatch Range near Ogden.

The Pacific mine[3] in American Fork district, Salt Lake County, is on a strong vein in Cambrian quartzite. Galena and pyrite are carried in a gangue of quartz and barite. The barite tends to localize in lenticular shoots, some of which, Loughlin states, are pure and could be hand picked to make a commercial ore. This mine is 20 miles from a railroad.

[1] Grasty, J. S., Barytes deposits of Tennessee: The Tradesman, May 1, 1913, pp. 36–37.
[2] Loughlin, G. F., oral communication to the writer.
[3] Butler, B. S., and Loughlin, G. F., A reconnaissance of the Cottonwood-American Fork mining region, Utah: U. S. Geol. Survey Bull. 620, pp. 207–208, 1915 (Bull. 620–I).

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VIRGINIA.

The marketed production of barytes in 1915 in Virginia was about three times as great as the output in 1914. The whole of the output in 1915 was made by two operators in the southwestern part of the State.

There are three types of barytes deposits in Virginia.[1] The most important commercially are the deposits in the Piedmont region of Campbell, Pittsylvania, and Bedford counties, and those in the valley region of Russell, Smythe, and Tazewell counties. Deposits in the Piedmont are also known in Louisa and Prince William counties.

Of least importance in recent years are the deposits in Fauquier and Prince William counties which occur in red Triassic limestones and shales and in pre-Cambrian crystalline rocks. The barite occurs as the cement of brecciated zones 4 to 8 feet wide, is of good quality, of the soft variety so far as mined, and is fairly clean.

A large part of the Virginia output of barytes in recent years has been from residual deposits in Campbell and Pittsylvania counties, that have been derived from the weathering of Cambrian and pre-Cambrian crystalline rocks including schists, quartzites, and limestones. The barite seems to have replaced certain beds of crystalline limestone, as the deposits are associated with that rock. Iron and manganese oxides are found in the clays and some deposits have produced ocher and umber pigments as well as barite. In a few places manganese ores have also been mined. The principal deposits are located near Evington and Toshes. In these deposits, galena, pyrite, and sphalerite accompany the barite, but at many places are not of consequence.

In the valley region barytes is found principally in residual clays derived from the Knox dolomite (Cambrian and Ordovician). It is, however, found in veins and replacement deposits in the unaltered limestone, where it is accompanied by sphalerite, galena, pyrite, and fluorite. The principal mining localities are near Marion, Smythe County, and North Tazewell, Honaker, and Lebanon, in Tazewell and Russell counties. In the last two counties there is a continuous belt of barite-bearing ground about 30 miles long extending in a northeasterly direction from Lebanon, Russell county, to a point near North Tazewell in Tazewell County. Clinch River follows the belt for some distance, cutting across it just south of Cedar Bluff and again south of Gardner. The residual barite is practically free from impurities.

BARIUM PRODUCTS.

For many years ground and floated barytes has been produced at various plants located in Kentucky, Missouri, North Carolina, South Carolina, Tennessee, and Virginia. Prior to 1914 a small quantity of barium chemicals was made in the United States, though there is little published information relative to this industry. It would

[1] Campbell, M. R., U S. Geol. Survey Geol. Atlas, Pocahontas folio (No. 26), 1896; Tazewell folio (No. 44), 1897; Bristol folio (No. 59), 1899.
Judd, E. K., Barytes industry of the South: Eng. and Min. Jour., vol. 83, pp. 751–752, 1907.
Watson, T. L., Geology of the Virginia barite deposits: Am. Inst. Min. Eng. Trans., vol. 37, pp. 953–976, 1907; Mineral resources of Virginia, pp. 307–327, Virginia Jamestown Exposition Com., 1907; Geology of the Virginia barite deposits: The Tradesman, Mar. 20, 1913, pp. 38–41; Mar. 27, 1913, pp. 31–33.
Watson, T. L., and Grasty, J. S., Barite of the Appalachian States: Am. Inst. Min. Eng. Bull. 98, pp. 374–381, February, 1915.

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appear that practically all the barium chemicals heretofore used were imported either from Germany, England, or France. In each of those countries there were barium chemical plants, though the industry was apparently most highly developed in Germany and England.

PRODUCTION.

Reports received by the Survey from 9 grinders, 8 makers of lithopone, and 4 barium chemical plants, producers in 1915, show that during the year 51,557 short tons of ground barytes, 46,494 short tons of lithopone, and 8,823 short tons of barium chemicals, made in the United States, were marketed.

Marketed production of barium products in 1915.

	Quantity (short tons).	Average price per ton.	Total value.
Ground barytes	51,557	$12.32	$635,318
Lithopone	46,494	80.88	3,760,472
Barium chemicals [a]	8,823	[b]	[a]

[a] Barium chemicals include the binoxide, carbonate, chloride, hydroxide, nitrate, sulphate (blanc-fixe), and sulphide.
[b] Value can not be reported.

Barytes was ground during 1915 at 3 plants in Missouri and at 1 plant each in Georgia, Maryland, North Carolina, South Carolina, Tennessee, and Virginia. There were 4 more grinding plants reporting in 1915 than in 1914. The average price of ground barytes was $12.95 a ton in 1914, and $12.32 in 1915. This reduction in average price is believed to be due to the sales of unbleached ground barytes from some plants at prices considerably below the average for bleached ground barytes.

Lithopone was reported made at 8 plants, 3 each in New Jersey and Pennsylvania, and 1 each in Delaware and Illinois. The Illinois plant is new, being the only additional plant reporting a production in 1915 and not in 1914. The average price of lithopone rose from $75.89 a ton in 1914 to $80.88 in 1915, but the prices reported by different companies varied considerably.

Barium chemicals were made at 1 plant each in California, Illinois, Tennessee, and West Virginia. Not all of the chemicals are made at each plant, in fact in some of them not more than three of the products are made. In view of the fact that some of the producing companies did not give values for their products and further that the values given varied so widely, it is not deemed advisable at this time to publish a total value for the output of barium chemicals.

IMPORTS.

According to statistics collected by the Bureau of Foreign and Domestic Commerce, Department of Commerce, the imports of barium chemicals in 1915 were valued at $282,094; as will be seen by the following table, this is a decrease of nearly 43 per cent from the 1914 imports and is less than the 1913 imports by 32 per cent. It is not entirely clear that manufactured barytes refers to what is known in the United States as ground barytes, but it is believed that this is the case.

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Value of barium products entered for consumption, 1911–1915.

	1911	1912	1913	1914	1915
Manufactured barytes[a]	$22,083	$26,848	$38,155	$30,483	$10,736
Lithopone	166,199	153,303	152,980	277,822	144,567
Barium carbonate:					
Natural	27,351	15,777	13,116	8,084	12,165
Manufactured		9,938	38,949	28,221	2,786
Barium binoxide	270,917	252,320	239,000	332,709	213,776
Barium chloride	28,896	27,655	37,620	68,866	31,295
Blanc-fixe or artificial barium sulphate	71,049	70,327	62,785	32,619	18,501
	586,495	556,168	582,605	778,804	438,826

[a] "Manufactured barytes," as given by the Bureau of Foreign and Domestic Commerce, is believed to be the equivalent of ground and floated barytes as used by the Geological Survey.

THE MANUFACTURE OF GROUND BARYTES.[1]

The treatment of crude barytes to make ground barytes varies in different plants. The general practice, however, seems to be to crush to about 1 inch and log-wash and jig to remove clay, calcite, fluorite, silica, and part of the iron oxide. This cleaned material is next crushed to one-fourth to one-eighth inch at some plants, and at others ground fine and subjected to a bleaching process. The bleaching, largely to remove iron oxide, is accomplished by treating the material with sulphuric acid from 8 to 12 hours in lead-lined wooden tanks. The bleached product is washed several times and ground in burr mills or pulverizers to pass 200 to 300 mesh, and in some plants is water floated to insure a uniformly fine product, and is then dried, pulverized, and packed. Much care is required not only in the bleaching, but also in the drying operation to insure a uniformly perfect color. Details of the manipulation during bleaching and of the drying machinery are not made public.

The softer grades of barytes are preferred by the grinders, as there is less wear on the machines in treating this class of material. However, in some plants, hard crystalline barytes is ground successfully. Several grades of ground barytes are on the market, varying from unbleached, coarsely-ground material to the finest grade of white-bleached and water-floated pigment. The following list includes all the companies reporting a production of ground barytes:

Barbour Chemical Works, 707 West Coast Life Building, San Francisco.
Carolina Barytes Co., Stackhouse, N. C.
Cherokee Chemical Co., 109 Hollingsworth Street, Baltimore, Md.
Elkhorn Chemical Co., Elsinore and Gilbert avenues, Cincinnati, Ohio.
J. C. Fink Mineral & Manufacturing Co., 101 Barton Street, St. Louis, Mo.
Nulsen, Klein & Krausse Manufacturing Co., Levee and Sidney Streets, St. Louis, Mo.
Point Milling & Manufacturing Co., Mineral Point, Mo.
Product Sales Co., 423–425 Equitable Building, Baltimore, Md.
Thompson, Weinman & Co., 100 William Street, New York, N. Y.

THE MANUFACTURE OF LITHOPONE.

Lithopone is a mixture of approximately 70 per cent barium sulphate, 25 to 29 per cent zinc sulphide, and 1 to 5 per cent zinc oxide, which is made by mixing hot solutions of barium sulphide and zinc

[1] The sections of this report dealing with the manufacture of barium products have been read and criticised by Mr. Hugh Rollin, of the Rollin Chemical Co., and Mr. Maximilian Toch, of the Durex Chemical Co., to whom the Survey desires to express its appreciation for their courtesy.

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sulphate. In the preparation of high-grade lithopone the solutions of barium and zinc compounds must be essentially pure. The precipitate from the tanks is filter-pressed, dried, subjected to considerable heat, quenched in water, ground to pulp, filter-pressed, dried, and packed for shipment. A recent paper by O'Brien[1] brings out the important points in the preparation of lithopone and indicates some of the features necessary to produce a light-proof product. Lithopone is sold under a great variety of trade names, such as Beckton White, Green Seal, Blue Seal, Sterling White, Fulton White, Phonolith. The following list includes the manufacturers of lithopone who reported production in 1915 or prospective production in 1916:

Beckton Chemical Co., 3500 Grays Ferry Road, Philadelphia, Pa.
Grasselli Chemical Co., Cleveland, Ohio.
N. Z. Graves Corporation, 22–24 South Third Street, Philadelphia, Pa.
Krebs Pigment & Chemical Co., Newport, Del.
Mantua Chemical Co., 3500 Grays Ferry Road, Philadelphia, Pa.
Midland Chemical Co., 80 East Jackson Boulevard, Chicago, Ill.
New Jersey Zinc Co., 55 Wall Street, New York, N. Y.

THE MANUFACTURE OF BARIUM CHEMICALS.

The principal barium chemicals made in the United States are the binoxide, carbonate, chloride, hydroxide, nitrate, and sulphate or blanc-fixe. Some crude barium sulphide ("Black Ash") is sold to makers of lithopone and manufacturers of chemicals who are not equipped to roast sufficient barytes to meet their needs.

As all the barium compounds are poisonous, care must be exercised in their manufacture. Naturally the salts which are only slightly soluble in water are not so dangerous as those which are more soluble. The sulphide is soluble in hot water. The carbonate is sparingly soluble in pure water and is slightly soluble in water containing carbonic acid. The chloride is soluble in water, particularly hot water, but is insoluble in strong hydrochloric acid and alcohol. Barium nitrate is slightly soluble in water, but is insoluble in concentrated nitric acid and alcohol. Barium sulphate is insoluble in water, but is slightly soluble in dilute acids and more so in strong acids.

As there are no published accounts of the actual methods used in manufacturing barium chemicals and as it is not ordinarily possible to inspect chemical plants, it is not known what methods are actually used in the preparation of the barium salts at various plants. Applied chemistry is, of course, essential to the success of this industry, yet a detailed knowledge of markets, not only for crude materials but also of first products, by-products, and labor is of prime importance.

The following notes, abstracted in part from Thorp's "Dictionary of applied chemistry" and Roscoe & Schorlemmer's "Treatise on chemistry," are not given as a method of procedure to be followed by those desiring to make barium chemicals, but for general information to those interested but not specializing in the subject:

The manufacturers of barium chemicals prefer to use washed, high-grade barytes of the soft variety; nevertheless they can, and some do, use barytes which could not be used for the highest grades of ground floated barytes. The first step in the barium chemical plants is the reduction of the barium sulphate to the sulphide, which is soluble in water. The barytes is finely crushed and mixed with a

[1] O'Brien, W. S., A study of lithopone: Jour. Phys. Chemistry, vol. 19, pp. 113–144, 1915.

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certain proportion of pulverized coal and common salt. The mix varies in different plants, but is generally stated to be about one-fourth coal by volume. This material is fed to rotating furnaces, where it is roasted from three to four hours. The charge is next leached in most plants, first, with a boiling, weak solution of barium sulphide, which is obtained by washing the leached material with hot water. The ash after the leaching and washing is waste, though it may contain some undissolved barium compounds. The extraction of barium sulphide is ordinarily stated to be 70 per cent, though it is known that a higher extraction can be made. The liquid from the barium sulphide leach is stored in large heated tanks, from which it is drawn into the different vats for the preparation of the various salts. Barium sulphide can be precipitated by allowing the solution to cool below 150°.

The processes of manufacture of the various chemicals are intricate and require special study and application of chemical and physical knowledge when done on a commercial scale. The manufacturing chemists do not make public the special methods which they have evolved for the preparation of pure salts. It is known in general that the carbonate and the sulphate can be precipitated from the hot sulphide liquor by the use of appropriate salts of sodium and that a salable sodium sulphide by-product will be formed. It is also known that barium chloride can be made by treatment of the sulphide liquor with hydrochloric acid or by roasting a mixture of barytes, charcoal, limestone, and calcium chloride, but the first precipitate requires purification. Barium nitrate can be made by treating the sulphide solution with nitric acid or by mixing hot saturated solutions of barium chloride and sodium nitrate. The preparation of the binoxide or peroxide (BaO_2) and hydroxide ($Ba(OH)_2$) are said to require a particularly high degree of technical skill, as very high and very low temperatures are required during the course of process and the materials require careful manipulation to insure uniformity. Barium monoxide or baryta (BaO) can be made by heating the nitrate till the evolution of red nitrous oxide fumes ceases, but the heated mass is liable to froth, though this can be prevented by using equal amounts of nitrate and sulphate, which reduces the yield. It can also be prepared from the carbonate by bringing that salt to a white heat when most of the carbon monoxide is driven off. The hydroxide ($Ba(OH)_2$) can be formed by the combination of baryta and water, but as a great amount of heat is evolved, its manufacture in this manner requires considerable care. It can also be prepared by passing moist carbon dioxide gas over heated barium sulphide forming the carbonate, after which superheated steam passed over the carbonate forms barium hydroxide with the evolution of carbon dioxide. The hydroxide can also be made by the electrolysis of barium hydrosulphide. Barium peroxide can be prepared by passing air freed from carbonic acid over baryta (BaO) heated to a dull red, or by treating heated baryta with powdered potassium chlorate, but this peroxide requires purifying.

The following companies reported to the Survey that they had made barium chemicals during 1915 or were about to begin the manufacture of one or more of the chemicals early in 1916:

Barbour Chemical Works, 707 West Coast Life Building, San Francisco, Cal.
Baryta Manufacturing Co., 205 Pearl Street, New York, N. Y.

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Chemical Products Co., 616 Majestic Building, Denver, Colo.
Chicago Copper & Chemical Co., 111 West Jackson Boulevard, Chicago, Ill.
Clinchfield Products Co., 120 Broadway, New York, N. Y.
Durex Chemical Co., 320 Fifth Avenue, New York, N. Y.
Elkhorn Chemical Co., Elsinore and Gilbert Avenues, Cincinnati, Ohio.
Globe Chemical Co., 1205 Regent Avenue, Cincinnati, Ohio.
Lamar Chemical Works, 44–56 Lewis Avenue, Jersey City, N. J.
Port Morris Chemical Works, 141 Locust Avenue, New York, N. Y.
Rollin Chemical Co., Charleston, W. Va.

USES OF BARIUM PRODUCTS.

Ground barytes of the lower unbleached grades is sold to manufacturing chemists and to paint manufacturers for incorporation in colored mixed paints; it can also be used in the preparation of rubber and in other industries where a colored product is made. The bleached and floated barytes of the finer grades is used as a white pigment in the preparation of ready mixed white paints and as a filler for the chemical pigments. In the paper industry it is largely used in the manufacture of heavy, stiff materials such as playing cards, bristol boards, and the like.

Lithopone is sold and used as a white pigment for ready mixed paints, being particularly used for the preparation of what are called the "sanitary flat wall paints," which are used to a large extent. It is also used in some enamels and calsomines, and in the rubber, paper, and cloth industries, where it is replacing barytes and some of the metallic pigments.

The barium chemicals have a wide variety of uses and may enter into the manufacture of other products. In the study of the industry the products have not been followed beyond the plants at which the chemicals are made from crude barytes. Barium binoxide or peroxide (BaO_2) apparently finds its principal market with the manufacturers of hydrogen peroxide, though some is believed to be used in the preparation of oxygen. This salt has the property of giving up part of its oxygen under certain conditions and of recombining with more oxygen under reverse conditions. This property is not, however, everlasting, and fresh supplies of the peroxide are frequently required.

Barium carbonate is used in the preparation of other barium chemicals—in rat poisons, as a water softener, in the manufacture of flat wall paints, and in the ceramic industry. Probably the last is its largest use at present. It is said that this material will fill the requirements of case-carbonizing steel, which was formerly filled by ground bone. Ground bone, which formerly commanded a price of $60 a ton, has risen in price and the makers of case-carbonized steel have been in search of a substitute. The barium carbonate for this purpose must contain no sulphur, but may carry calcium and small amounts of other impurities. It is said that the demand should be several thousand tons a year.

Barium chloride is used in the preparation of other barium salts, as a water softener, a chemical reagent, particularly for the purification of table salt, to some extent in the ceramic arts, and in the preparation of rat poisons.

Barium hydroxide is used as a chemical reagent. It can be used in the refining of sugar, but on account of its poisonous nature is not often employed; another reason why it is not used is the difficulty of its regeneration from the carbonate which is formed by the reactions.

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Barium monoxide has its principal use in the preparation of the binoxide and hydroxide. It is used to some extent in the manufacture of special glasses.

Barium nitrate is used as a chemical reagent in the preparation of "green fire" and green signal lights and in the manufacture of an explosive known as saxifragin.

Barium sulphate, usually sold under the name of blanc-fixe or permanent white, is a pigment extensively used in the paint industry, in the manufacture of highly glazed papers and of putty, and in the fabrication of rubber and of lake colors.

STRONTIUM.

CONDITION OF THE INDUSTRY.

No strontium-bearing ores of domestic origin were reported sold during the year 1915, and so far as the Survey has learned none of the American deposits were exploited. During the year some interest in domestic deposits has been manifest. It is understood that the manufacturers of red fire, both for signal and display purposes, and the beet-sugar interests have been looking into the question of obtaining strontium from home sources. It would seem that in view of the increased price of sugar it might be profitable for the beet-sugar makers to use the more effective strontia method rather than the one now in use. However, the substitution of the strontia process will require some time to bring about, and it depends on a number of economic factors concerning which the Survey has no information. Commercial strontium ores should contain at least 95 per cent strontium sulphate. At present English celestite is largely used on the eastern seaboard, where the strontium salts are made, and is laid down at the works at approximately $12 a ton.

IMPORTS.

According to the reports of the Bureau of Foreign and Domestic Commerce, Department of Commerce, the imports of strontium oxide, protoxide of strontium, and strontianite or mineral carbonate of strontium were valued at $1,016 in 1914 and at $6,411 in 1915. Imports of the strontium salts are free from duty. No figures are available for imports of celestite, strontium sulphate, used by manufacturers of strontium salts, this material being classed with all other chemicals not specially provided for in the present tariff.

DOMESTIC SOURCES OF SUPPLY.

From all available information it seems most probable that the deposits in northwestern Ohio and southeastern Michigan have the greatest possibility of early exploitation. It is understood that in a number of the limestone quarries in the vicinity of Toledo celestite occurs in workable quantity, though the mineral is not now handled separately. It is said that in certain broken and open beds of dolomite (magnesian limestone) there are at many quarries in the vicinity of Toledo masses of celestite which could easily be saved by hand sorting the coarse material and jigging the fines. The installation of expensive machinery is hardly warranted under present conditions, yet some celestite could be hand sorted from limestone on picking belts and would probably find a market.

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The deposits[1] in Arizona and California appear to be extensive, but they are far from market and are of realtively low grade. It is possible that plants for making the various commercial strontium compounds may eventually be built where both of these sources could be drawn upon. It would seem, however, that the development of these deposits must wait on the decision of the sugar refiners to adopt the strontia prcoess.

In Texas[2] there are said to be commercial deposits of celestite in the vicinity of Austin, where nodules of celestite occur in soft limestones of Crotaceous age. These deposits can be easily worked. Samples of the material assayed by Ledoux & Co. show 97.64 per cent $SrSo_4$.

In May, 1916, samples of apparently pure celestite were received by the Survey from Ira R. Browning, of Castle Dale, Utah, who reports that there appears to be a commercial deposit of similar material in Emery County, Utah, about 50 miles southeast of Green River.

Celestite has recently been recognized by G. F. Loughlin, of the United States Geological Survey, as a gangue mineral at the Lead Hill mine, on Salina Creek, 4 miles east of Salina, Utah. Owing to its high specific gravity it has given considerable trouble in the concentration of the lead ore. The analysis of a specially concentrated sample is given below:

Analysis of celestite ore from Lead Hill mine, Mo.

SiO_2	6.9	SrO	45.8	SO_3	34.8
TiO_2, etc	1.0	CaO	.9	H_2O	.3
Al_2O_3	.6	MnO	Trace.	PbO	6.6
Fe_2O_3	.3	BaO	None.		
FeO	.3	CO_2	1.9		99.4

The calculated mineral composition, based on this analysis and on microscopic study, shows about 80 per cent celestite, 8 per cent cerusite (lead carbonate), and the remainder quartz and silicates, with a little calcite and limonite. The average middlings from the ore contain, in addition to the above minerals, a considerable quantity of zinc blende, whose specific gravity is so near that of celestite that the two can not be easily separated mechanically. The two minerals, however, are not everywhere closely associated on the ore body, and it may be worth while to experiment further in the concentration of celestite with a view to making it a by-product of the lead and zinc ores.

The Survey has recently received samples of both strontianite and celestite from a deposit owned by W. B. Alverson, of La Conner, Skagit County, Wash. The deposit is said to be a northwestward-trending vein in serpentine, which outcrops on a low hill that rises from tidewater. It is estimated that 10,000 tons of commercial strontium-bearing material is available above the water level. The samples received by the Survey were analyzed by A. A. Chambers, with the following results: Celestite, $SrSO_4$, 97.03 per cent; CO_2, trace. Strontianate, $SrCO_3$, 75.80 per cent; SO_3, 0.75 per cent; calcium, present.

[1] Phalen, W. C., Celestite deposits in California and Arizona: U. S. Geol. Survey Bull. 540, pp. 521–523, 1914.

[2] Texas Geol. Survey First Rept., p. 125, 1889; Third Rept., p. 229, 1891. Hill, R. T., U. S. Geol. Survey Twenty-first Ann. Rept., pt. 7, pp. 144–147, 1901. Hess, F. L., Eng. and Min. Jour., vol. 88, p. 117, 1909. Phalen, W. C., Celestite deposits in California and Arizona: U. S. Geol. Survey Bull. 540, pp. 524–525, 1913.

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The mineral celestite (strontium sulphate) ordinarily is found well crystalized in tabular or prismatic forms, though it may occur fibrous or massive. It is usually vitreous, with a somewhat pearly luster, and has a bluish cast in the interior of the crystals, though some celestite has a reddish cast. Masses of celestite are heavy (specific gravity 3.95–3.97) and somewhat resemble barytes. A knife will easily scratch the crystals, which range in hardness from 3 to 3.5.

Strontianite (strontium carbonate) is not common. Where found it occurs as white, yellowish-white, or greenish-white masses made up of imperfect needle crystals, and somewhat resembles aragonite. Its hardness varies from 3 to 3.5 and its specific gravity from 3.68 to 3.72.

Both of these strontium minerals impart a brilliant red color to the flame, which is intensified if the particle of mineral is moistened with hydrochloric acid. This flame is deeper and more brilliant than the yellowish red produced by calcium. The sulphate is practically insoluble in acids, but the carbonate effervesces readily in cold acids. Both minerals fuse, the sulphate easily to a pearly glass, the carbonate on the edges of particles which swell and sprout.

USES OF STRONTIUM SALTS.

The principal commercial strontium salts are: Strontium hydroxide, used in the beet sugar industry, and strontium nitrate and chloride, used in pyrotechnics. Small quantities of various organic and inorganic salts, such as acetate, lactate, bromide, iodide, arsenite, and phosphate are used in medicine. It is said that formerly strontium nitrate was used in the manufacture of some types of smokeless powder, but this method of manufacture has been superseded. The use of strontium salts by powder companies at present is believed to be for the fabrication of illuminating or signal shells, in which the value of the strontium salt lies only in the brilliant red color it imparts to the flame produced by explosion.

The strontium salts are made from celestite by roasting that mineral with coal to produce the soluble sulphide, leaching with water and precipitating with suitable reagents. The chemical process is intricate, and the separation of relatively pure strontium salts from barium and calcium is particularly difficult. Concerning the purification of strontium nitrate, Roscoe and Schorlemmer [1] say:

> The purification is best accomplished by dissolving the carbonate in hydrochloric acid, precipitating the foreign metals by strontium oxide, followed by chlorine water, and then precipitating most of the barium by the addition of concentrated hydrochloric acid. Sulphuric acid is then added and the greater portion of the mixed sulphates are converted into carbonate by ammonium carbonate. The precipitate is next dissolved in dilute nitric acid and fractionally precipitated with sulphuric acid until no barium is contained in the precipitate. Calcium is removed from the nitrate by repeated precipitation of the strontium nitrate by alcohol.

Strontium monoxide can be prepared from the nitrate by ignition, and the hydroxide from the monoxide by the addition of water.

[1] Roscoe, H. E., and Schorlemmer, C., Treatise on chemistry, vol. 2, p. 596, 1913.

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CEMENT.[1]

By Ernest F. Burchard.

INTRODUCTION.

The cement industry showed no unusual features in 1915. In view of the experiences of 1914, when the production of Portland cement was checked for the first time, manufacturers exercised considerable caution, the result of which was a slight increase in the volume of shipments, a small decrease in the quantity of cement manufactured, and a considerable decrease in the stocks of cement on hand—all indicating a correction of the tendency toward overproduction that has manifested itself at times during the last few years.

The year 1915 opened with decidedly slack conditions in the cement industry, for there was little new construction work in sight, and the general developments of the early months of 1915 were not such as to dispel the gloomy outlook in certain parts of the country. The rate of production of many mills was therefore cut down below the rate of shipment in order to effect a partial clearance of the large stocks that had accumulated during 1914. In general, there was a slight improvement during the second and third quarters of 1915, and in the last three or four months there was a marked change for the better, in both demand and prices, so that at the beginning of 1916 the outlook was brighter than it had been for several seasons.

In general, prices averaged 6.7 cents lower per barrel in 1915 than in 1914, though toward the end of the year they were considerably higher. The statistics show that the general volume of business was about the same as in 1914, though it was not uniformly distributed throughout the year. During the early part of the year the demand for cement was not great, and in some districts the industry was depressed during the summer by excessive rainfall. The cement industry is particularly subject to local conditions, especially in inland districts, for cement is too bulky to be shipped in great quantities by rail into competitive territory except under extraordinary circumstances. Naturally, therefore, certain districts, such as those that produce cotton and those in which industrial agitation has recently checked progress, have felt the depression more keenly than others; and in districts where large public works are in progress, or where advantage was taken of the apparently favorable prices of structural materials in order to push extensions of factories and new construction work, the production and shipments of cement increased.

Through the prompt and courteous response of nearly all the manufacturers of Portland cement it was possible to release to the press, on January 1, 1916, an estimate of the production, shipments, and stocks of Portland cement in the United States, by districts, in 1915.

[1] The statistical tables presented in this chapter were prepared by Mrs. H. L. Bennit.

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The estimated production and shipments were, respectively, 0.4 per cent and 0.2 per cent lower than the final figures, and the estimated stocks were 1.7 per cent lower than those shown by the final returns.

The output of natural and puzzolan cements decreased in 1915, but the value of natural cement sold was greater than that for 1914.

The new features introduced in the chapter on the cement industry in 1914—namely, a statistical compilation of the shipments of Portland cement into States and a tabulation of exports of cement into the different countries—are here continued, though it has been difficult to get the necessary statistics from operators in some States promptly. In fact, the completion of this report was delayed at least a month by delays in getting figures from half a dozen factories.

MARKETED PRODUCTION OF PRINCIPAL HYDRAULIC CEMENTS.

The total quantity of Portland, natural, and puzzolan cements marketed or shipped from the mills in the United States in 1915 was 87,685,222 barrels, valued at $75,155,102, as compared with 87,257,552 barrels, valued at $80,533,203, in 1914. This represents an increase in quantity of 427,670 barrels, or nearly 0.5 per cent, and a decrease in value of $5,378,101, or 6.7 per cent. It should be noted here that a table in which the statistics of these three kinds of cement are combined to form a total in barrels is necessarily slightly inconsistent, for the weights per barrel of different kinds of cement are different. A barrel of Portland cement is supposed to weigh 380 pounds net, but the weights of barrels of cement of the other two classes are not uniform. Natural cement is sold in barrels containing 240 to 285 pounds and generally supposed to contain 265 pounds; puzzolan cement has been supposed to weigh 330 pounds to the barrel, but barrels of it weighing from 240 to 380 pounds have been reported, the weight depending on the specific gravity of the cement, its fineness, and the number of sacks constituting a barrel. It would be better if all cements could be sold by the hundredweight.

The distribution of the total marketed production of the three main classes of cement for 1913–1915, is shown in the following table:

Principal hydraulic cements shipped from factories in the United States in 1913, 1914, and 1915.

Class.	1913		1914		1915	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
Portland	88,689,377	$89,106,975	86,437,956	$80,118,475	86,891,681	$74,756,674
Natural	744,658	345,889	751,285	351,370	750,863	358,627
Puzzolan	107,313	97,663	68,311	63,358	42,678	39,801
	89,541,348	89,550,527	87,257,552	80,533,203	87,685,222	75,155,102

The historical table that follows gives the production of natural, Portland, and puzzolan cements so far as recorded by the Survey. The figures represent actual production of Portland cement for all years and of natural and puzzolan cements until 1911, inclusive, after which the figures for these cements represent marketed production, or shipments. No figures for production or stocks are collected for natural and puzzolan cements because production and shipments are generally nearly the same and stocks are relatively small.

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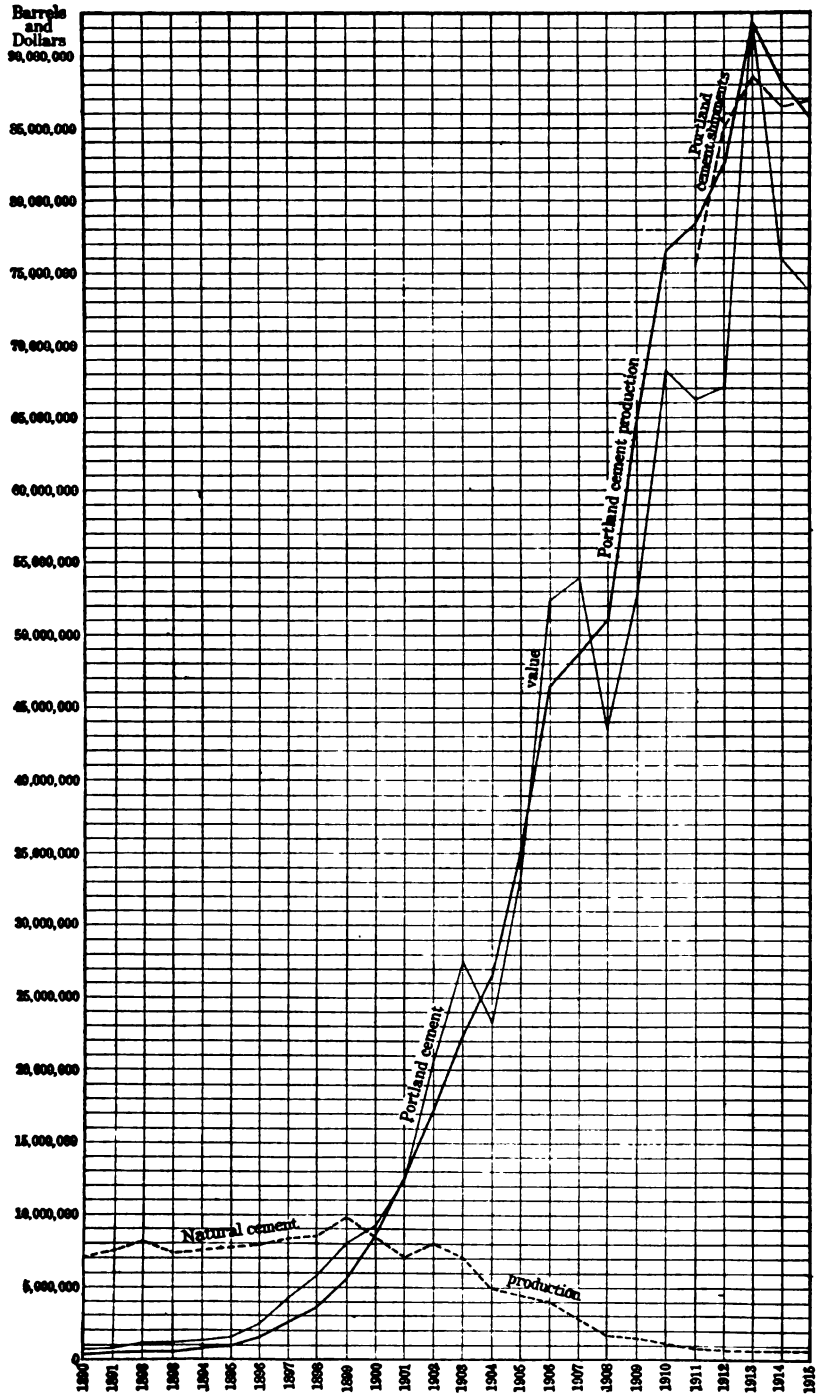

FIGURE 8.—Production of Portland and natural cements and value of Portland cement, 1890–1915, and shipments of Portland cement, 1911–1915.

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Principal hydraulic cements produced in the United States, 1818–1915.

Year.	Natural cement.		Portland cement.		Puzzolan cement.		Total.	
	Quantity. (barrels).	Value.	Quantity (barrels).	Value.	Quantity. (barrels).	Value.	Quantity. (barrels).	Value.
1818–1829	300,000	$246,000					300,000	$246,000
1830–1839	1,000,000	850,000					1,000,000	850,000
1840–1849	4,250,000	3,612,500					4,250,000	3,612,500
1850–1859	11,000,000	9,350,000					11,000,000	9,350,000
1860–1869	16,420,000	13,957,000					16,420,000	13,957,000
1870–1879	22,000,000	18,700,000	82,000	$246,000			22,082,000	18,946,000
1880	2,030,943	1,726,707	42,000	126,000			2,072,943	1,852,707
1881	2,440,000	2,379,000	60,000	150,000			2,500,000	2,529,000
1882	3,165,000	3,481,500	85,000	191,250			3,250,000	3,672,750
1883	4,100,000	4,100,000	90,000	193,500			4,190,000	4,293,500
1884	3,900,000	3,510,000	100,000	210,000			4,000,000	3,720,000
1885	4,000,000	3,200,000	150,000	292,500			4,150,000	3,492,500
1886	4,350,000	3,697,500	150,000	292,500			4,500,000	3,990,000
1887	6,692,744	5,186,877	250,000	487,500			6,942,744	5,674,377
1888	6,253,295	4,533,639	250,000	487,500			6,503,295	5,021,139
1889	6,531,876	4,702,951	300,000	500,000			6,831,876	5,202,951
1890	7,441,116	3,822,501	335,500	704,050			7,776,616	4,526,551
1891 [a]	7,767,979	3,671,147	454,813	967,679			8,222,792	4,638,826
1892	8,211,181	3,991,455	547,440	1,152,600			8,758,621	5,144,055
1893	7,411,815	3,251,757	590,652	1,158,138			8,002,467	4,409,895
1894	7,563,488	3,635,731	798,757	1,383,473			8,362,245	5,019,204
1895	7,741,077	3,895,424	990,324	1,586,830			8,731,401	5,482,254
1896	7,970,450	4,049,202	1,543,023	2,424,011	12,265	$12,250	9,525,738	6,485,463
1897	8,311,688	3,862,392	2,677,775	4,315,891	48,329	48,500	11,037,792	8,226,783
1898	8,418,924	3,888,728	3,692,284	5,970,773	233,000	198,050	12,344,208	10,057,551
1899	9,868,179	4,814,771	5,652,266	8,074,371	335,000	268,000	15,855,445	13,157,142
1900	8,383,519	3,728,848	8,482,020	9,280,525	365,611	274,208	17,231,150	13,283,581
1901	7,084,823	3,056,278	12,711,225	12,532,360	272,689	198,151	20,068,737	15,786,789
1902	8,044,305	4,076,630	17,230,644	20,864,978	478,555	425,672	25,753,504	25,366,380
1903	7,030,271	3,675,520	22,342,973	27,713,319	525,896	542,502	29,899,140	31,931,341
1904	4,866,331	2,450,150	26,505,881	23,355,119	303,045	226,651	31,675,257	26,031,920
1905	4,473,049	2,413,052	35,246,812	33,245,867	382,447	272,614	40,102,308	35,931,533
1906	4,055,797	2,423,170	46,463,424	52,466,186	481,224	412,921	51,000,445	55,302,277
1907	2,887,700	1,467,302	48,785,390	53,992,551	557,252	443,998	52,230,342	55,903,851
1908	1,686,862	834,509	51,072,612	43,547,679	151,451	95,468	52,910,925	44,477,656
1909	1,537,638	652,756	64,991,431	52,858,354	160,646	99,453	66,689,715	53,610,563
1910	1,139,239	483,066	76,549,951	68,205,800	95,951	63,286	77,785,141	68,752,092
1911	926,091	378,533	78,528,637	66,248,817	93,230	77,786	79,547,958	66,705,136
1912	821,231	367,222	82,438,096	67,016,928	91,864	77,363	83,351,191	67,461,513

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1913	744,658	345,890	92,007,131	92,557,617	107,313	97,663	92,949,102	93,001,169	
1914	751,285	351,370	88,230,170	81,799,368	68,311	63,354	89,049,706	82,204,096	
1915	750,863	358,627	80,914,907	73,886,820	42,678	39,801	85,708,448	74,285,248	
	234,323,417	149,179,644	856,433,138	810,476,964	4,906,757	3,937,665	1,036,563,312	963,563,293	

a The figures for 1890 and previous years are estimates made at the close of each year and are believed to be substantially correct. Since 1890 the official figures are based on practically complete returns from all producers.

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PORTLAND CEMENT.

PRODUCTION AND SHIPMENTS.

The total production of Portland cement in the United States in 1915, as reported to the United States Geological Survey, was 85,914,907 barrels, valued at $73,886,820. This represents a decrease in quantity of 2.6 per cent, and a decrease in value of nearly 9.7 per cent. The value assigned is computed at a price of 86 cents a barrel, the average price of the Portland cement shipped in 1915.

The shipments of Portland cement from the mills in the United States in 1915 were, according to reports received by the Survey, 86,891,681 barrels, valued at $74,756,674, an increase in quantity of 453,725 barrels, or 0.5 per cent, and a decrease in value of $5,361,801, or 6.7 per cent. The average price per barrel for the whole country in 1915, according to these figures, was 86 cents, compared with 92.7 cents in 1914, a decrease of 6.7 cents a barrel, or about 7.2 per cent. This represents the selling price of cement in bulk at the mills, including cost of labor and packing, but not the value of the sacks or barrels. The average price per barrel for the country is 16.1 cents higher than the average price received for Portland cement in the Lehigh district and is near the average price received in Indiana, Missouri, the Ohio-western Pennsylvania district, and the Plains States, but falls 53.9 cents below the average received in California, where Portland cement brought the highest price of the year.

The quantity of Portland cement made in 1915 (85,914,907 barrels of 380 pounds) is approximately equivalent to 14,574,850 gross tons, and the value per ton is about $5.07. The tonnage of Portland cement made in 1915 was equivalent to nearly 50 per cent of the quantity of pig iron produced in that year, but the total value of the cement was not quite 19 per cent of the value of the pig iron. The average value of the cement per ton was about 38 per cent of that of pig iron.

The average price of Portland cement in the United States has been increased slightly over the average for ordinary gray cement by the inclusion in the total shipments of a small quantity of white Portland cement. This white cement was produced in the Lehigh district, so that the value for that district has been increased in greater proportion than that of the other districts. Two mills, both in Pennsylvania, reported the production of white Portland cement in 1915.

PRODUCTION AND SHIPMENTS BY STATES.

In the following table the production and shipments and the corresponding values of Portland cement for 1914 and 1915, by States, are arranged in the order of rank of production for 1915, provided there are three or more producers or shippers in a single State, or permission is given to publish figures where there are less than three. By the term "producer" is meant a Portland cement manufacturing company, whether the company operates one or more plants. In the table the term "producing plant" is applied to a mill or group of mills located at one place and operated by one company, but each establishment at a different place is counted as a plant. There were producing plants in 26 States in 1914, and in 25 States in 1915, but since only 14 of these States contained three or more plants it has been necessary to group together in this table a number of States that are

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not closely related geographically. This disadvantage is, however, compensated for in the table "Portland cement produced and shipped, by districts," in which statistics are given for groups of States—generally not more than three—that are geographically related.

Portland cement produced and shipped in 1914 and 1915, by States.

[Figures opposite P relate to production; those opposite S to shipments.]

State.		Active plants.		1914		1915		Per centage of change in quantity, 1915.	Average factory price per barrel.	
		1914	1915	Quantity (barrels).	Value.	Quantity (barrels).	Value.		1914	1915
Pennsylvania	P	20	20	26,570,151		28,648,941		+ 7.8		
	S	20	20	25,985,106	$20,944,787	28,188,450	$20,252,961	+ 8.5	0.806	0.718
Indiana	P	5	5	9,595,923		8,145,401		−15.1		
	S	5	5	9,540,288	8,342,164	8,577,513	7,336,821	−10.1	.874	.855
Illinois	P	5	4	5,401,605		5,156,869		− 4.5		
	S	5	5	5,284,022	4,848,522	5,435,655	4,884,026	+ 2.9	.918	.899
New York	P	8	7	5,886,124		5,043,889		−14.3		
	S	8	8	5,474,191	5,020,720	5,275,101	4,039,215	− 3.6	.917	.766
Michigan	P	11	11	4,285,345		4,765,294		+11.2		
	S	11	11	4,218,429	4,064,781	4,727,768	4,454,608	+12.1	.964	.942
Missouri	P	5	5	4,723,906		4,626,771		− 2.1		
	S	5	5	4,706,389	4,485,744	4,628,484	4,007,679	− 1.7	.953	.866
Iowa	P	3	3	4,233,707		4,559,630		+ 7.7		
	S	3	3	4,224,076	4,008,915	4,590,336	4,119,952	+ 8.7	.949	.898
California	P	7	7	5,075,114		4,503,306		−11.3		
	S	7	7	5,004,633	6,698,905	4,532,452	6,338,918	− 9.4	1.339	1.399
Kansas	P	9	9	3,431,142		3,580,287		+ 4.3		
	S	10	9	3,237,906	2,643,415	3,780,735	2,826,443	+16.8	.816	.748
Ohio	P	5	5	1,962,047		1,948,826		− .7		
	S	5	5	1,919,859	1,913,797	1,961,469	1,917,920	+ 2.2	.997	.978
Texas	P	4	4	2,100,341		1,939,363		− 7.7		
	S	4	4	2,096,140	2,686,653	1,932,828	2,518,233	− 7.8	1.282	1.303
New Jersey	P	3	2	3,674,800		1,579,173		−57.0		
	S	3	3	3,530,476	3,081,205	1,977,474	1,473,499	−44.0	.873	.745
Washington	P	5	5	2,017,344		1,496,216		−25.8		
	S	5	5	2,045,465	2,303,433	1,378,107	1,790,499	−32.6	1.126	1.299
Utah	P	3	3	981,100		625,577		−36.2		
	S	3	3	974,723	1,317,575	655,116	823,995	−37.5	1.352	1.260
Other States[a]	P	17	16	8,291,521		9,295,303		+12.1		
	S	17	16	8,196,253	7,757,859	9,250,253	7,971,905	+12.9	.947	.862
Total	P	110	106	88,230,170		85,914,907		− 2.6		
	S	111	109	86,437,956	80,118,475	86,891,681	74,756,674	+ .5	.927	.860

[a] Alabama, Arizona, Colorado, Georgia, Kentucky, Maryland, Montana, Nebraska, Oklahoma, Tennessee, Virginia, and West Virginia in 1914 and 1915, with the exception of Arizona, which made no output in 1915.

The more important features with regard to individual States brought out by this table are the increases in both production and shipments in Pennsylvania, Michigan, and Kansas, all large producers of Portland cement, and the decreases in Indiana, New York, California, Texas, and New Jersey, the first three of which are normally large producers.

PRODUCTION AND SHIPMENTS BY COMMERCIAL DISTRICTS.

The division of the cement-producing territory into geographic units termed "commercial districts" is based to some extent on the relations of the Portland cement plants to their trade territory. These relations are, of course, governed largely by transportation facilities and rates, and in forming the districts it has been found advisable to divide Pennsylvania, Indiana, and Texas in order to group the plants commercially. Possibly other divisions may be made in future reports.

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Portland cement produced and shipped in 1914 and 1915, by districts.

[Figures opposite P relate to production; those opposite S to shipments.]

Commercial district.		Active plants.		Production and shipments (barrels).			Average factory price per barrel.		
		1914	1915	1914	1915	Per centage of change, 1915.	1914	1915	Per-centage of change, 1915.
Lehigh district (New Jersey and eastern Pennsylvania)	P.	20	19	24,614,033	24,876,442	+ 1.1			
	S.	20	20	23,968,554	24,598,950	+ 2.6	$0.809	$0.699	−13.6
New York	P.	8	7	5,886,124	5,043,389	−14.3			
	S.	8	8	5,474,191	5,275,101	− 3.6	.917	.766	−16.5
Ohio and western Pennsylvania	P.	8	8	7,592,065	7,300,498	− 3.8			
	S.	8	8	7,466,387	7,528,383	+ .8	.876	.855	− 2.4
Michigan and northeastern Indiana	P.	13	13	5,214,557	5,485,951	+ 5.2			
	S.	13	13	5,157,613	5,480,428	+ 6.3	.960	.944	− 1.7
Kentucky and southern Indiana	P.	3	3	2,930,735	2,828,561	− 3.5			
	S.	3	3	2,932,008	2,762,941	− 5.8	.717	.703	− 2.0
Illinois and northwestern Indiana	P.	6	5	11,532,805	10,242,369	−11.2			
	S.	6	6	11,316,945	10,879,855	− 3.9	.932	.907	− 2.7
Maryland, Virginia, and West Virginia	P.	4	4	2,784,988	3,193,805	+14.7			
	S.	4	4	2,793,036	3,166,721	+13.4	.877	.816	− 7.0
Tennessee, Alabama, and Georgia	P.	5	5	2,672,210	3,010,037	+12.6			
	S.	5	5	2,577,099	3,099,770	+20.3	.935	.756	−19.1
Iowa and Missouri	P.	8	8	8,957,613	9,186,401	+ 2.6			
	S.	8	8	8,930,465	9,218,320	+ 3.2	.940	.882	− 6.2
Great Plains States (Kansas, Nebraska, Oklahoma, and central Texas).	P.	15	15	6,253,731	6,274,863	+ .3			
	S.	16	15	6,016,774	6,517,258	+ 8.3	.930	.872	− 6.2
Rocky Mountain States (Arizona,[a] Colorado, Utah, Montana, and western Texas)	P.	8	7	2,698,151	2,472,069	− 8.4			
	S.	8	7	2,754,591	2,453,095	−10.9	1.306	1.289	−13.0
Pacific Coast States (California and Washington)	P.	12	12	7,092,458	5,999,522	−15.4			
	S.	12	12	7,050,098	5,910,559	−16.2	1.277	1.375	+ 7.7
Total	P.	110	106	88,230,170	85,914,907	− 2.6			
	S.	111	109	86,437,956	86,891,681	+ .5	.927	.860	− 7.2

[a] Arizona had no output in 1915.

According to this table there was in 1915, compared with 1914, an increase in production in six districts—Lehigh, Michigan-northeastern Indiana, Maryland-Virginia-West Virginia, Tennessee-Alabama-Georgia, Iowa-Missouri, and the Great Plains States—and an increase in shipments in these districts and in the Ohio-western Pennsylvania district. There was a decrease in production in six districts—New York, Ohio-western Pennsylvania, Kentucky-southern Indiana, Illinois-northwestern Indiana, the Rocky Mountain States, and Pacific coast—and a decrease in shipments in five districts—New York, Kentucky-southern Indiana, Illinois-northwestern Indiana, Rocky Mountains, and Pacific coast. The largest percentage of increase of production, 14.7 per cent, was reported from the Maryland-Virginia-West Virginia district; the largest increase in shipments, 20.3 per cent, was made in Tennessee-Alabama-Georgia. The northeastern and the western parts of the United States and the Illinois-Indiana-Kentucky region showed the bulk of the decrease in output in 1915.

The net change for the country at large was a decrease in production of 2,315,263 barrels, or 2.6 per cent, and an increase in shipments amounting to 453,725 barrels, or 0.5 per cent. In 1915 the shipments exceeded the production by 976,774 barrels. In no other year since 1912 have shipments exceeded production.

The United States Geological Survey has collected the statistics of shipments of Portland cement only during the last five years, and these data are summarized as follows:

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Portland cement shipped from mills in the United States, 1911–1915.

Year.	Quantity (barrels).	Value.
1911	75,547,829	$63,762,368
1912	85,012,556	69,109,800
1913	88,689,377	89,106,975
1914	86,437,956	80,118,475
1915	86,891,681	74,756,674

LEHIGH DISTRICT.

The production of Portland cement in the Lehigh district, in eastern Pennsylvania and western New Jersey, in 1915 was 24,876,442

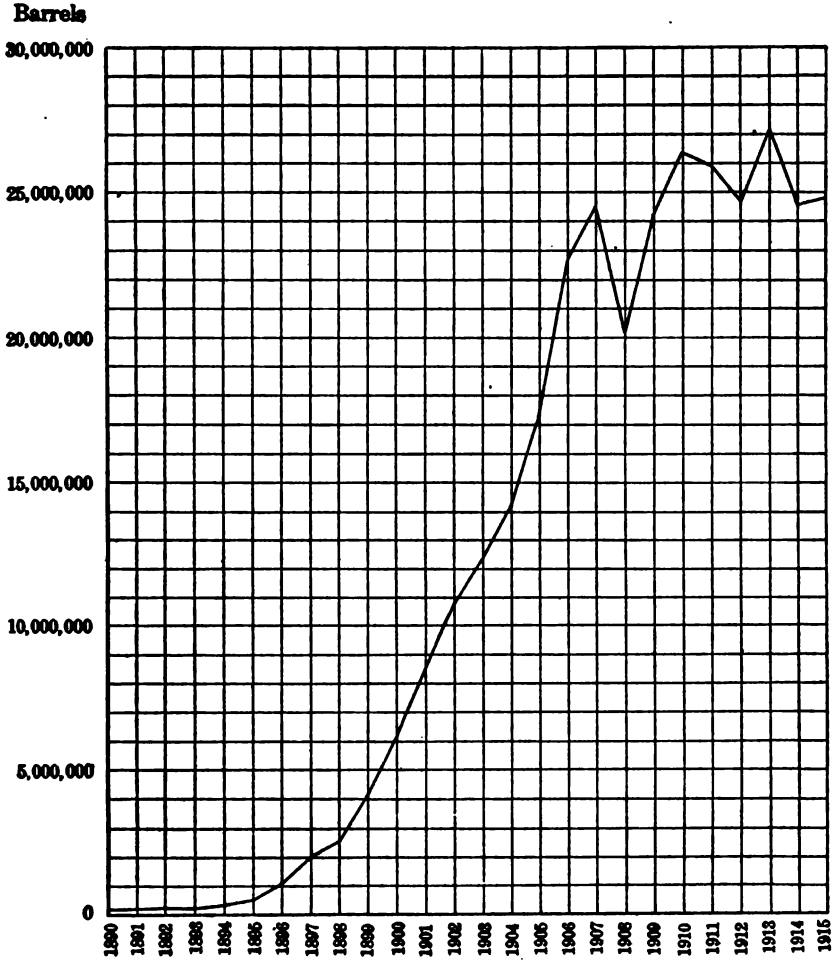

FIGURE 9.—Production of Portland cement in the Lehigh district, 1890–1915.

barrels, an increase of 261,509 barrels, or 1.1 per cent, compared with 1914. The shipments from mills in this district in 1915 amounted to 24,598,950 barrels, an increase of 630,396 barrels, or 2.6 per cent, over 1914. The total value of the Portland cement shipped from

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this district in 1915 was reported as $17,204,920, at an average price of 69.9 cents a barrel in bulk at the mills, as compared with $19,401,780, or 80.9 cents a barrel, in 1914. The production of white Portland cement from two plants in this district is included in the figures for 1915. As the average price reported for the white cement was considerably higher than that reported for ordinary gray cement, the average price for the district is slightly higher than if it represented gray Portland cement alone.

Nineteen plants produced and 20 plants shipped Portland cement from the Lehigh district in 1915, as compared with 20 producers and shippers in 1914.

The Lehigh district has, except in five years, shown a steady increase in production of Portland cement from 1890 to the present time. The years in which slight decreases were recorded are 1893, 1908, 1911, 1912, and 1914. The first two decreases were coincident with years of general business depression, but the decrease in 1911 and 1912 may perhaps be attributed in large part to overproduction in 1910 and to the building of many mills in other parts of the United States, which have restricted the trade territory of the Lehigh district. The percentage which the Lehigh output bears to the total output for the United States has decreased each year since 1899, except in 1907 and 1915.

The following table and figure 9 show the production of Portland cement in the Lehigh district since 1890.

Portland cement produced in the Lehigh district and in the United States, 1890–1915.

Year.	Lehigh district (barrels).	United States (barrels).	Percentage made in Lehigh district.	Year.	Lehigh district (barrels).	United States (barrels).	Percentage made in Lehigh district.
1890	201,000	335,500	60.0	1903	12,324,922	22,342,973	55.2
1891	248,500	454,813	54.7	1904	14,211,039	26,505,881	53.7
1892	280,840	547,440	51.3	1905	17,368,687	35,246,812	49.3
1893	265,317	590,652	44.9	1906	22,784,613	46,463,424	49.0
1894	485,329	798,757	60.8	1907	24,417,686	48,785,390	50.0
1895	634,276	990,324	64.0	1908	20,200,387	51,072,612	39.6
1896	1,048,154	1,543,023	68.1	1909	24,246,706	64,991,431	37.3
1897	2,002,059	2,677,775	74.8	1910	26,315,359	76,549,951	34.4
1898	2,674,304	3,692,284	72.4	1911	25,972,108	78,528,637	33.1
1899	4,110,132	5,652,266	72.7	1912	24,762,083	82,438,096	30.0
1900	6,153,629	8,482,020	72.6	1913	27,139,601	92,097,131	29.5
1901	8,595,340	12,711,225	67.7	1914	24,614,933	88,230,170	27.9
1902	10,829,922	17,230,644	62.8	1915	24,876,442	85,914,907	29.0

STOCKS AT MILLS.

The stock of Portland cement on hand at the various factories at the end of 1915, according to reports, amounted to 11,781,166 barrels, compared with 12,773,463 barrels on hand at the close of 1914, a decrease in stock of 992,297 barrels, or 7.8 per cent, during 1915. The stocks at many factories in 1914 were revised by the producers, at the request of the Survey, and the stock reported for 1915 checks with the revised total for 1914 within 0.13 per cent of the stock calculated by balancing the shipments for 1915 against the production of 1915 plus the stock at the close of 1914, and it is believed that this agreement is as close as it can be made, for the volume of stocks can not be measured with great accuracy.

State and district stocks at the close of 1914 and 1915 and the United States totals at the close of each of the last five years are given in the next three tables.

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Portland cement in stock Dec. 31, 1914, and Dec. 31, 1915, by States.

State.	Quantity (barrels).		Percentage of change in 1915.
	1914 (revised).	1915	
California	610,962	577,713	− 5.4
Illinois	734,099	454,024	−38.2
Indiana	1,926,532	1,494,490	−22.4
Iowa	609,293	578,587	− 5.0
Kansas	632,512	429,826	−32.0
Michigan	538,696	574,373	+ 6.6
Missouri	863,430	861,717	− .2
New Jersey	564,642	164,341	−70.1
New York	954,218	723,019	−24.2
Ohio	217,647	205,063	− 5.8
Pennsylvania	3,440,302	3,904,644	+13.5
Texas	254,413	260,842	+ 2.5
Utah	104,204	74,670	−28.3
Washington	363,212	480,534	+32.3
Other States[a]	959,301	997,323	+ 4.0
	12,773,463	11,781,166	− 7.8

[a] Alabama, Colorado, Georgia, Kentucky, Maryland, Montana, Nebraska, Oklahoma, Tennessee, Virginia, and West Virginia in 1914 and 1915.

Portland cement in stock, Dec. 31, 1914, and Dec. 31, 1915, by districts.

District.	Quantity (barrels).		Per centage of change in 1915.
	1914 (revised).	1915	
Lehigh district (New Jersey and eastern Pennsylvania)	3,121,593	3,400,936	+ 8.9
New York	954,218	723,019	−24.2
Ohio and western Pennsylvania	1,100,998	873,112	−20.7
Michigan and northeastern Indiana	678,388	682,062	+ .5
Kentucky and southern Indiana	435,742	501,432	+15.1
Illinois and northwestern Indiana	2,118,099	1,480,024	−30.1
Maryland, Virginia, and West Virginia	332,695	359,913	+ 8.2
Tennessee, Alabama, and Georgia	388,839	281,919	−27.5
Iowa and Missouri	1,472,723	1,440,304	− 2.2
Great Plains States (Kansas, Nebraska, Oklahoma, and central Texas)	985,611	750,874	−23.8
Rocky Mountain States (Colorado, Utah, Montana, and western Texas)	210,383	229,324	+ 9.0
Pacific coast States (California and Washington)	974,174	1,058,247	+ 8.6
	12,773,463	11,781,166	− 7.8

Portland cement in stock in the United States at the close of 1911, 1912, 1913, 1914, and 1915.

	Barrels.		Barrels.
1911	10,385,789	1914	12,773,463
1912	7,811,329	1915	11,781,166
1913	11,220,328		

PORTLAND CEMENT CONSUMED.

In the chapter on the cement industry in Mineral Resources for 1914 a table was presented to show the consumption of Portland cement in the States and the dependencies of the United States. It was not planned to prepare such a table every year unless the cement manufacturers desired it, as it was realized that a serious burden is already placed upon them by the many inquiries from Government, State, and commercial organizations, and, naturally, it is becoming

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increasingly difficult for the statistician to obtain the necessary data within the limit of time and funds available for the canvass. However, the interest in this investigation was shown so conclusively by the leading Portland cement manufacturers that it has been decided to make this table a permanent feature of the Survey's cement statistics as long as the manufacturers are willing to furnish figures showing the shipments of cement into the several States. The consumption in the outlying possessions of the United States is represented simply by the official statistics of exports to those countries. Of course the shipments of cement into a State do not equal the consumption in that State during the same period, but if taken for a long period they should afford a very fair index to that consumption. The simplest available common index appears to be the estimated consumption per capita which has been obtained by comparing the shipments into States and possessions with the population for the States and possessions in 1914 and 1915 as estimated by the Bureau of the Census. Perhaps a truer index to the market possibilities of a State would be one that should take into account not only the population but the per capita wealth, the nativity of the population and the main occupations, the proportion between urban and rural population, the geographic situation of the State or Territory, the assessed valuation of property and indebtedness, the transportation service, the public works in progress or in prospect, and many other important factors. However, the data in the accompanying table are presented in the hope that they may be of interest and service to the cement industry, with the idea that no business man will draw unwarranted conclusions from them. For instance, though Mississippi, Alabama, Arkansas, and South Carolina show a per capita consumption of Portland cement in 1914 and 1915 of only 0.11 to 0.17 barrel—the lowest for the United States and the outlying possessions—no one would for a moment believe that these States offer the most promising field for a cement salesman. It might be admitted, however, by even the most pessimistic that there is room in such fields for more educational work to show the advantages of using cement and concrete.

The discrepancy between the official figures of the Bureau of Foreign and Domestic Commerce for exports of cement, given on page 203, and the exports reported by manufacturers, as given in the next table, is due to the following facts: Cement shipped from mills destined for foreign countries is regarded by the shipper as exported, whether or not it leaves the country during that calendar year, but the Bureau of Foreign and Domestic Commerce bases its export figures on the cement that actually leaves the country. The exports given by that bureau include all natural or puzzolan cement which may have been exported, while the table of per capita consumption relates only to Portland cement. Another source of apparent disagreement is the fact that the lump figure for unspecified exports reported by manufacturers does not include the exports to Alaska, Hawaii, Porto Rico, and the Philippine Islands, statistics for which are given separately in the same table.

The per capita consumption shown by the table necessarily falls short of the total apparent consumption by the quantity of the imports. These, however, are small—only 120,906 barrels in 1914

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and 42,218 barrels in 1915; but there are no data to show just which States consumed the imported cement.

The highest per capita consumption in 1914 was that of California (1.70). Montana (1.68) and Iowa (1.64) followed closely. In 1915 Iowa led with a per capita consumption of 1.54, and California and Minnesota stood second and third, their per capita consumption being, respectively, 1.46 and 1.40. In 1914 the per capita consumption was more than 1 barrel in 15 States and Alaska; in 1915 it was more than 1 barrel in 14 States, but in Alaska it dropped from 1.29 to 0.53. In 1914 nine of these divisions were west of Mississippi River and seven of them were west of the Rocky Mountains, but in 1915 only four of the larger cement-consuming States were in the area west of Mississippi River. This change is consistent with the decrease in production and shipments in Rocky Mountain and Pacific coast States indicated in foregoing tables. Comparison of the figures by States for the two years brings out some wide variations and abrupt changes in the estimated consumption per capita. Out of 52 divisions 3 apparently showed no change, 26 showed decreases, and 23 showed increases. The general average per capita consumption for all the United States and dependencies was 0.77 barrel in 1914 and 0.76 barrel in 1915. Data for the Panama Canal Zone, which were included in the table in the chapter on the cement industry in 1914, have been omitted here, as they are likely to be misleading rather than useful in the present discussion. When the changes in per capita consumption by States are examined it may be inferred that large decreases or increases were due mostly to changes in demand for cement for public works. In California, for instance, the buildings for the expositions were practically finished at the close of 1914; in Arizona and Idaho concrete work on certain large irrigation projects were nearing completion in 1914; and in the District of Columbia a large concrete bridge was built and increased areas of sidewalk and street pavements were laid.

The estimate of per capita consumption follows:

Estimated per capita consumption of Portland cement in the United States and outlying possessions in 1914 and 1915.

State.	1914			1915		
	Population (estimated).	Consumption (shipments to States).	Estimated consumption per capita.	Population (estimated).	Consumption (shipments to States).	Estimated consumption per capita.
		Barrels.	*Barrels.*		*Barrels.*	*Barrels.*
Alabama	2,269,945	517,405	0.23	2,301,277	384,563	0.17
Alaska	64,680	83,567	1.29	64,757	34,347	.53
Arizona	239,053	286,380	1.20	247,299	220,220	.89
Arkansas	1,686,480	400,607	.24	1,713,102	276,756	.16
California	2,757,895	4,678,493	1.70	2,848,275	4,004,672	1.46
Colorado	909,537	176,035	.19	985,799	540,962	.58
Connecticut	1,202,688	1,172,095	.97	1,223,583	1,642,516	1.34
Delaware	209,817	116,029	.55	211,598	171,981	.81
District of Columbia	353,378	341,227	.97	358,679	441,417	1.23
Florida	848,111	460,974	.54	870,802	483,039	.55
Georgia	2,776,513	511,385	.18	2,816,289	617,124	.22
Hawaii	208,063	96,775	.47	211,902	169,732	.80
Idaho	395,407	473,206	1.19	411,996	242,872	.59
Illinois	5,986,781	6,760,054	1.13	6,069,519	6,732,906	1.11

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Estimated per capita consumption of Portland cement in the United States and outlying possessions in 1914 and 1915—Continued.

State.	1914			1915		
	Population (estimated).	Consumption (shipments to States).	Estimated consumption per capita.	Population (estimated).	Consumption (shipments to States).	Estimated consumption per capita.
		Barrels.	*Barrels.*		*Barrels.*	*Barrels.*
Indiana	2,779,467	3,028,663	1.08	2,798,142	2,950,657	1.06
Iowa	2,221,755	3,641,953	1.64	2,358,066	3,633,369	1.54
Kansas	1,784,897	1,450,882	.81	1,807,221	1,762,393	.98
Kentucky	2,350,731	874,538	.37	2,365,185	827,909	.35
Louisiana	1,773,482	583,159	.33	1,801,306	776,177	.43
Maine	762,787	347,866	.46	767,038	437,935	.57
Maryland	1,341,075	1,624,180	1.21	1,351,941	1,367,732	1.01
Massachusetts	3,605,522	2,618,421	.73	3,662,339	2,911,949	.80
Michigan	2,976,030	3,664,149	1.24	3,015,442	3,950,532	1.31
Minnesota	2,213,919	3,125,930	1.41	2,246,761	3,143,999	1.40
Mississippi	1,901,882	206,782	.11	1,926,778	194,319	.11
Missouri	3,372,886	2,940,638	.87	3,391,789	2,892,781	.85
Montana	432,614	726,245	1.68	446,054	575,076	1.29
Nebraska	1,245,873	1,057,970	.85	1,258,924	1,250,010	.99
Nevada	98,726	56,034	.57	102,730	42,523	.41
New Hampshire	438,662	214,997	.49	440,584	342,031	.78
New Jersey	2,815,663	2,779,819	.99	2,881,840	3,498,063	1.22
New Mexico	383,551	262,410	.68	396,917	252,278	.64
New York	9,899,761	11,582,337	1.17	10,086,568	10,372,387	1.02
North Carolina	2,339,452	529,643	.23	2,371,095	570,472	.24
North Dakota	686,966	175,844	.26	713,083	246,793	.35
Ohio	5,026,898	6,735,027	1.34	5,088,627	7,074,563	1.39
Oklahoma	2,026,534	508,233	.25	2,114,307	671,714	.32
Oregon	783,239	733,316	.94	809,490	536,060	.66
Pennsylvania	8,245,967	7,200,703	.87	8,383,992	7,320,313	.87
Philippine Islands	8,650,937	392	.....	8,742,562	65	.....
Porto Rico	1,184,489	232,117	.20	1,200,286	228,473	.19
Rhode Island	591,215	316,374	.54	602,765	378,027	.63
South Carolina	1,590,015	176,693	.11	1,607,745	272,115	.17
South Dakota	661,583	428,002	.65	680,046	430,229	.63
Tennessee	2,254,754	802,711	.36	2,271,379	736,397	.32
Texas	4,257,554	1,821,628	.43	4,343,710	1,741,228	.40
Utah	414,518	442,400	1.07	424,300	421,184	.99
Vermont	361,205	192,912	.53	362,452	209,173	.58
Virginia	2,150,009	1,008,492	.47	2,171,014	1,178,465	.54
Washington	1,407,865	1,557,263	1.11	1,471,043	1,034,201	.70
West Virginia	1,332,910	1,250,557	.94	1,359,474	1,067,967	.79
Wisconsin	2,446,716	3,134,920	1.28	2,473,533	3,164,581	1.28
Wyoming	168,736	92,693	.55	174,148	115,169	.66
Unspecified	.....	97,026	.....	.....	120,067	.....
	108,889,493	84,298,151	.77	110,755,853	84,663,583	.76
Exports reported by manufacturers, but not included above	.....	2,139,805	.....	.....	2,228,098	.....
Total shipped from cement plants	.....	86,437,956	.....	.....	86,891,681	.....

TOTAL QUANTITY CONSUMED.

An estimate of the total consumption of Portland cement in the United States may be made by adding the imports to the shipments and subtracting the exports from the sum. Of course, a variable but considerable stock of cement is at all times in transit, in warehouses at distributing points, and awaiting use on the ground at large jobs, so that the estimate thus made is, at best, only roughly approximate. Still another uncertain element in this estimate is the fact that as imports and exports are classed as hydraulic cement, the records do not discriminate between Portland and other cements. Portland cement, however, constitutes by far the greater part of the exports, and, as the tables show, the imports are small. The apparent domestic consumption in 1914 amounted to 84,418,665 barrels, and

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in 1915 it was about 84,368,868 barrels, a decrease of 49,797 barrels, or about 0.06 per cent, as compared with 1.6 per cent in 1914.

The following table gives the figures necessary for estimates of consumption so far as available, as prior to 1911 no records are at hand for stocks:

Apparent domestic consumption of Portland cement, 1911–1915, in barrels.

Year.	Shipments.	Imports.	Exports.	Apparent consumption.
1911	75,547,829	164,670	3,135,409	72,577,090
1912	85,012,556	68,503	4,215,532	80,865,527
1913	88,689,377	84,630	2,961,358	85,809,649
1914	86,437,956	120,906	2,140,197	84,418,665
1915	86,891,681	42,218	2,565,031	84,368,868

PRICES.

Average prices of Portland cement per barrel in bulk at the factories are shown in the tables of shipments by States and districts during 1914 and 1915. According to these figures the price in 1915 ranged between 69.9 cents in the Lehigh district and $1.399 in California, as compared with 71.7 cents in the Kentucky-southern Indiana district and $1.352 in Utah, respectively, in 1914. The average price for the whole country was 86 cents in 1915, as compared with 92.7 cents in 1914, a decrease of 6.7 cents per barrel, or 7.2 per cent. Inspection of the State table shows that in California, Texas, and Washington there were slight increases in average price, but district averages show an increase only in the Pacific coast district.

The decreases in average price in the Lehigh, New York, Tennessee-Alabama-Georgia, and Rocky Mountain districts were more than the average; all the others were below the average.

Figure 10 (p. 204) illustrates graphically the rapid early decline and the recent fluctuations in prices of Portland cement, and the accompanying table summarizes the same data.

Average factory price per barrel in bulk of Portland cement, 1870–1915.

1870–1880	$3.00	1894	$1.73	1905	$0.94
1881	2.50	1895	1.60	1906	1.13
1882	2.01	1896	1.57	1907	1.11
1883	2.15	1897	1.61	1908	.85
1884	2.10	1898	1.62	1909	.813
1885–1888	1.95	1899	1.43	1910	.891
1889	1.67	1900	1.09	1911	.844
1890	2.09	1901	.99	1912	.813
1891	2.13	1902	1.21	1913	1.005
1892	2.11	1903	1.24	1914	.927
1893	1.91	1904	.88	1915	.86

MANUFACTURING CONDITIONS.

Portland cement was manufactured at 106 plants in 1915, compared with 110 plants in 1914. Six plants suspended production—one each in Arizona, Illinois, Kansas, Michigan, New Jersey, and New York, and one plant each in Kansas and Michigan, idle in 1914, resumed operations in 1915, making a net loss of four plants. Shipments were reported from 109 plants in 1915, compared with 111 plants in 1914, four plants having suspended shipments—one in

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Arizona, two in Kansas, and one in Michigan. The plants in Kansas and Michigan that resumed shipments in 1915 reduced the net decrease to two plants. No commercial production was reported from

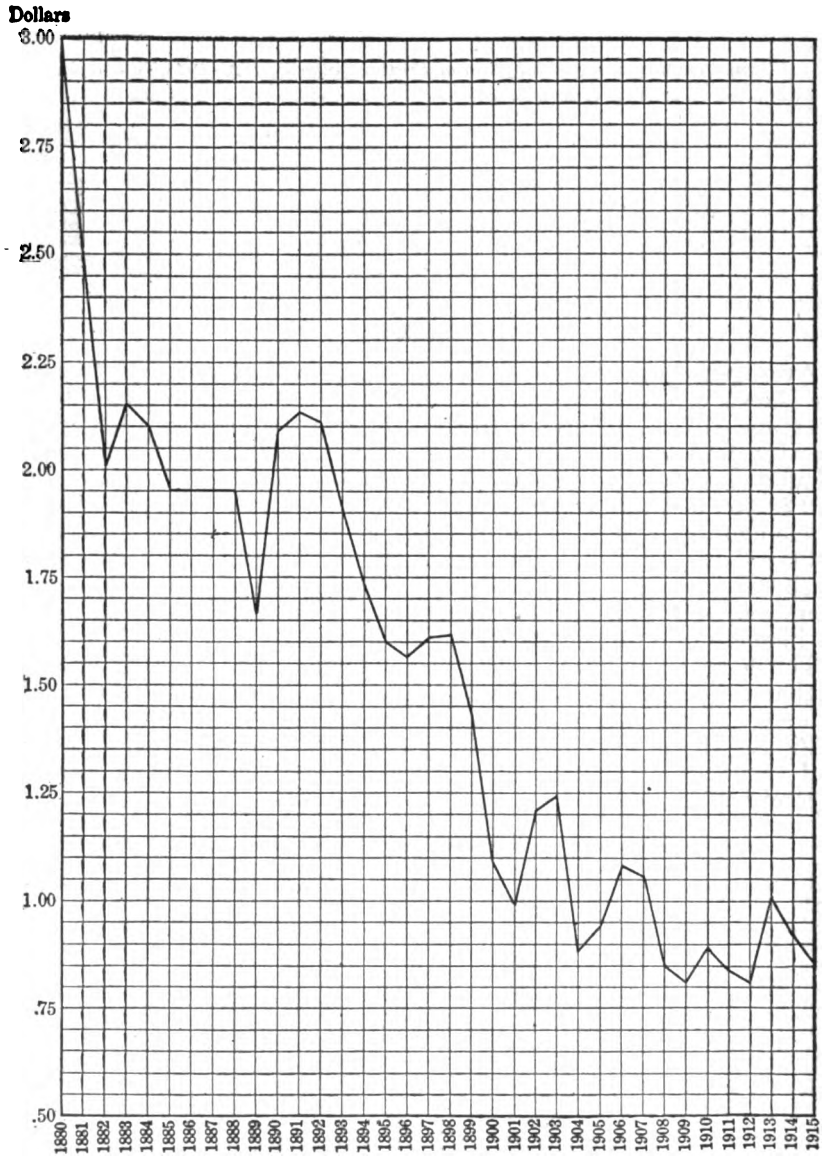

FIGURE 10.—Range in average factory price per barrel of Portland cement, 1880–1915.

new plants in 1915, but it is expected that additions to the list will be made in 1916.

The total number of rotary kilns reported in plants that operated in 1915 was 754, compared with 839 in 1914, a net reduction of 85 kilns. The number of small kilns (40 to 60 feet long) was reduced by 71;

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the number of kilns between 60 and 90 feet long was decreased by 9; and one additional kiln of large dimensions (150 feet or more long) was reported in use. Reductions were reported in the number of nearly all the kilns of intermediate sizes. The kilns were distributed by lengths as shown in the table below:

Lengths of rotary cement kilns in active plants in the United States, 1913–1915.

Length (feet).	Number of kilns.			Length (feet).	Number of kilns.		
	1913	1914	1915		1913	1914	1915
40 to 60	157	170	99	125	157	157	148
60 to 90	145	133	124	125 to 140	63	63	63
100	93	94	86	150 or more	38	46	47
110	117	76	88				
120	103	100	99		873	839	754

The apparent total annual kiln capacity in 1915 of all the plants, either active or only temporarily closed, according to the producers' reports, due allowance being made for the customary loss of time from breakdowns and from necessary shutdowns for repairs, was about 125,000,000 barrels of Portland cement, compared with about 115,000,000 barrels in 1914, estimated on the same basis. According to these figures the total production for 1915 (85,914,907 barrels) was nearly 69 per cent of the cement-producing capacity of the country, whereas the production in 1914 represented 76 per cent of the capacity. The apparent average output per kiln in 1915 was not quite 114,000 barrels, as compared with 105,000 barrels in 1914.

A summary of kiln fuels reported in 1915 shows that 84 plants, employing 597 kilns, burned powdered coal; that 15 plants, employing 105 kilns, burned oil; and that 2 plants, employing 10 kilns, burned natural gas. As compared with 1914 there was a decrease of 4 plants and of 72 kilns burning coal; an increase of 1 plant, but a decrease of 2 kilns burning oil; and an increase of 1 plant and of 6 kilns burning natural gas. At certain plants more than one fuel is used. For instance, one plant reports coal and oil; another, coal, oil, and gas; one plant reports coal and gas; one, oil and gas; and one, producer gas.

The following table summarizes these data for 1914 and 1915, together with the quantities and percentages of Portland cement produced with coal, oil, and gas, and with two or more of these fuels:

Summary of Portland cement kiln fuels in 1914 and 1915.

Fuel.	1914				1915			
	Number of plants.	Number of kilns.	Barrels of cement.	Percentage of total.	Number of plants.	Number of kilns.	Barrels of cement.	Percentage of total.
Coal	88	669	72,471,772	82.1	84	597	70,440,529	82.0
Coal and oil	1	24	4,183,842	4.7	1	24	5,124,074	6.0
Coal, oil, and gas	1	5	712,314	.8	1	5	729,797	.8
Coal and gas	2	14	1,564,113	1.8	1	7	830,988	1.0
Oil	14	107	7,698,720	8.7	15	105	7,581,467	8.8
Oil and gas	2	15	1,292,578	1.5	1	5	469,762	.5
Producer gas	1	1	65,420	.1	1	1	72,777	.1
Natural gas	1	4	241,411	.3	2	10	665,513	.8
	110	839	88,230,170	100.0	106	754	85,914,907	100.0

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RECOVERY OF POTASH FROM PORTLAND CEMENT MATERIALS.

The collection or elimination of dust in the cement plant is one of the most important problems in cement manufacture at present, and incidental to the study of this problem the year 1915 witnessed an awakening of interest on the part of several cement companies to the possibility of recovering potash as a by-product in cement manufacture. The pioneer in this field was the Riverside Portland Cement Co., the plant of which is at Riverside, Cal. The operations at this plant have been mentioned by W. C. Phalen in recent chapters of Mineral Resources on potash salts. The early efforts of the Riverside company, which employs the Cottrell electrical precipitation process,[1] were directed rather toward precipitating waste dust than toward recovering potash, but the company soon discovered that, although the raw mix contained only about 0.2 per cent of potash, the dust contained potash in considerable quantities and a large portion of it is now being recovered. Since the supply of potash from Germany has been cut off the Riverside company has contracted for the sale of its potash at prices that yielded large returns on the investment for the dust-collecting equipment. The Western Precipitation Co., of Los Angeles, Cal., controls the license for all applications of the Cottrell precipitation process to cement manufacture.

The abnormally high prices for potash that have prevailed since the shortage began to be felt have, of course, stimulated many and diverse efforts to discover or devise a domestic source of potash, and the first plant in the East to follow the lead of the Riverside plant is that of the Security Cement & Lime Co., at Security, near Hagerstown, Md., where in May, 1916, the company's potash-recovery plant was rapidly nearing completion. The limestone used by the Security company in making Portland cement contains more than the average percentage of potash (K_2O), a fact which lends encouragement to the effort to recover it at this plant. After thoroughly investigating the situation Mr. John Jermain Porter, vice president of the company, recommended and was authorized to install the Cottrell electrical process.

Extracts from a published description of the plant being erected at Security, Md., are given below:[2]

> The recovery plant, which is now nearing completion at the Security Company, is a compact one, being about 35 by 70 feet and 65 feet high. It is of steel frame construction covered with sheet-steel plates, requiring altogether about 180 tons of steel, and is built on heavy concrete foundations. This building is called the treater plant. Dampers are placed at the top of each of the five kiln stacks and direct pipe connections are made from these stacks to a gooseneck pipe which leads to the top of the treater building, this bringing all the gases at one point at the top of the building.
>
> In the upper part of the building, at regular intervals, are placed vertically 800 sections of steel pipe 16 feet long by 12 inches in diameter. Through the middle of each pipe is suspended a wire which is to be charged with electric current of 60,000 to 70,000 volts. This current produces an intense electrical field in the pipe and the effect of this field is to drive all solids in the fumes to the sides of the pipe. The pipes are arranged in two parallel sections, each section containing 400 pipe. About once an hour the gas is shut off from each section of the treater in rotation and the pipe is slightly rapped mechanically to shake the accumulated dust down into steel hoppers below. The gas passes through dampers in the sides of the collecting hoppers and is drawn out by exhaust fans while the dust accumulates in the hoppers.

[1] For details of this process see Schmidt, W. A., Cottrell processes of electrical precipitation: Canadian Min. Inst. Trans., vol. 18, pp. 110-133, 1915.

[2] Recovery of potash at Security cement plant: Mfrs. Record, May 11, 1916, pp. 44-45.

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The bottom of the hoppers are arranged at an angle, allowing the accumulated dust to be fed through a spout to belt conveyors, which carry it to an adjoining building, where it is packed for shipment.

This process does not interfere in the slightest with the ordinary methods of making cement, except mechanical draft is substituted for natural draft.

In the operation of the Riverside Portland Cement Co.'s plant it was shown that the current required was extremely small, because this process does not consume large volumes of current, as there is no return wire. There is, of course, a certain amount of current lost through leakage.

The plant is almost entirely mechanical in its operation and based upon conservative figures it is estimated that the total cost will not exceed $20 per day for labor, maintenance, and power at the plant which the Security company is erecting, this being a five-kiln plant with 2,600 to 2,800 barrels of cement a day.

The raw material of the Security company contains slightly over 1 per cent of potash, or potassium oxide. The percentage of total potash volatilized in the kilns varies all the way from 30 to 60 per cent. It is of course possible that, after this process is put into more use, a method can be devised to volatilize an even larger percentage.

It is estimated that the Security plant will recover at least 80 per cent of the potash passing through the treater and that this will give the company a production of approximately 4 tons per day, although it is possible this will vary and an increased production will be obtained after the plant has become fully adjusted and certain experiments in operation are more fully worked out.

The Security plant now uses about 800 tons of raw material per day and this contains a total of 8 tons of potash, which passes through the kilns. It has been found that the potash is driven off principally in the form of sulphate with a small amount of carbonate.

This plant is being constructed under plans furnished by the Western Precipitation Co., and under the direct supervision of the cement company's engineer.

In June, 1916, a dust recovery plant employing the Cottrell process was being installed at the new plant of the Universal Portland Cement Co., at Duluth, Minn. It is not planned at present to attempt to recover potash but to regrind and burn this dust into cement clinker.

The Western Precipitation Co. reports that it has made analyses of a large number of samples of raw mix used by several cement mills in the United States and finds that the potash content of the raw mix used at Riverside is much lower than the average. This affords encouragement for the hope that the problem of potash recovery may be more generally undertaken by cement manufacturers in the near future.

A process in which it is proposed to reverse the order of products and make cement as a by-product from potash is outlined in a recent publication as follows:[1]

After about eight years' experimental work, subsequently followed by several months' operation in a practical demonstrating plant at Catasauqua, Pa., where a large cupola was available, it is now proposed to enter the commercial field with the Brown process for the production of hydraulic cement as a by-product in the manufacture of potassium salts from feldspar and limestone. A 20-ton per day potassium salt plant is being constructed at Buffalo, N. Y., by the Buffalo Potash & Cement Corporation, 49 Wall Street, New York, N. Y., which will produce daily 1,000 barrels of cement. The process is covered by several United States and foreign patents, three patents being issued in 1915.

The methods employed are to use crushed limestone and feldspar, or other potassium silicate rocks in such proportions that the resultant fused mass will carry approximately 50 per cent of lime. The materials are placed in the furnace without drying or grinding and are thoroughly fused and maintained at a temperature of 1,300° C., at which temperature the potassium salts are volatilized and carried along with the furnace gases. These gases are used for raising steam in the waste-heat boilers, which steam furnishes all the power required for the operation of the plant. After the gases are cooled down sufficiently—that is, to about 400° F.—the entrained potassium salts are collected in cyclone collectors, or Cottrell apparatus, and the last traces

[1] Hydraulic cement is a by-product of potash plant: Cement and Eng. News, May, 1916, p. 114; also Concrete Age, May, 1916, p. 21.

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of the potassium salts are sent through wet washers, thereby saving practically all of the volatilized potassium salts.

After the potassium salts are volatilized, the molten material issues from the furnace in a stream which is similar in appearance to molten slag, but has properties widely different from the slag of a blast furnace. This material is granulated and treated with salt solutions of such a nature that when it has been granulated and become cold it bears a striking similarity to Portland cement clinker. When the clinkers are ground and mixed with a small percentage of gypsum, or other materials for regulating the set, the cement is ready for use.

The technical investigation and experimental work were done under the direction of H. E. Brown, consulting engineer, of New York City, to whom the patents were issued.

FOREIGN TRADE IN CEMENT.

EXPORTS.

A table showing by countries the quantity and value of cement shipped from the United States was given in the chapter on cement in Mineral Resources for 1914, but the following table, which affords a comparison of the details of exports for two years, is of greater interest:

Hydraulic cement exported from the United States in 1914 and 1915.[a]

Destination.	1914		1915	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.
Argentina	121,128	$161,788	118,454	$153,025
Australia and Tasmania	1,206	3,682	[b] 645	[b] 1,983
Azores and Madeira Islands	22	65	25	32
Belgium	160	542		
Bermuda	5,153	6,782	3,037	3,758
Bolivia			1,918	2,651
Brazil	165,001	202,727	430,938	520,366
British Guiana	5,005	7,120	18,058	23,386
British Honduras	2,460	4,018	2,732	4,269
British India	186	446	191	557
British Oceania			35	63
British South Africa	10	33	1,440	1,867
British West Africa	1,490	2,163	168	219
British West Indies:				
Barbados	380	532	4,140	5,417
Jamaica	12,288	17,865	38,941	52,213
Trinidad and Tobago Islands	9,905	14,077	30,205	39,499
Other British West Indies	4,412	6,481	8,601	11,691
Canada	73,036	131,036	28,764	46,879
Canary Islands			1,092	2,054
Chile	32,411	43,099	66,848	89,743
Colombia	60,512	82,335	45,669	59,457
Costa Rica	13,917	22,452	17,974	25,714
Cuba	663,792	933,424	579,738	788,047
Danish West Indies	303	635	1,201	1,781
Dominican Republic			30,934	41,164
Dutch East Indies			2,527	4,009
Dutch Guiana			3,791	5,169
Dutch West Indies	3,953	6,440	8,621	12,797
Ecuador	9,821	12,327	28,801	39,127
England	2,023	5,630	18,167	25,586
Egypt	7	11		
France			90	113
French Guiana	12	18	680	908
French Oceania			100	198
French West Indies	5,033	7,789	7,005	10,377
Germany	633	1,850		
Guatemala	8,641	13,872	15,014	19,937
Haiti	15,805	21,631	19,866	27,163
Honduras	25,155	50,338	21,804	39,903
Hongkong	25	33	1	3
Ireland	120	340		

[a] Statistics compiled from records of Bureau of Foreign and Domestic Commerce, Department of Commerce.

[b] Australia in 1915 only.

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Hydraulic cement exported from the United States in 1914 and 1915—Continued.

Destination.	1914		1915	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.
Italy			1,000	$1,244
Japan	1,032	$1,380	21	59
Japanese China			438	895
Liberia	1,106	1,450	438	649
Mexico	87,460	155,657	112,533	191,633
Miquelon, Langley, etc	10	20		
Netherlands			12	32
Newfoundland	383	567	13,438	15,434
New Zealand	285	1,140	337	423
Nicaragua	4,828	8,610	7,555	12,958
Norway	2,500	3,800		
Panama	653,525	953,256	686,024	823,363
Peru	60,413	83,200	88,170	116,023
Philippine Islands	392	504	65	151
Portugal	40	80	10	14
Portuguese Africa	5	11	501	727
Salvador	7,167	12,321	21,262	36,067
Santo Domingo	40,482	55,503	26,351	34,579
Scotland			5	8
Spain			92	124
Turkey in Asia	135	432	453	1,394
Uruguay	5,811	7,493	13,115	17,161
Venezuela	30,618	41,304	34,906	47,298
	2,140,197	3,088,809	2,565,031	3,361,451

In 1915 the total quantity of hydraulic cement exported to foreign countries, including the Philippines and the Panama Canal Zone, was 2,565,031 barrels, most of it Portland cement, valued at $3,361,451 at the United States ports of shipment, or an average of approximately $1.31 a barrel, as compared with 2,140,197 barrels, valued at $3,088,809, or about $1.44 a barrel in 1914. The quantity exported in 1915 was not quite 3 per cent of the total production of hydraulic cements, as compared with 2.4 per cent exported in 1914.

The exports have never been great, the largest quantity, that in 1912, having been only 4,215,532 barrels. The exports for 1915, however, showed an increase of nearly 20 per cent over those of 1914, and as this increase was due largely to greater exports to South American countries and the West Indies, it appears that the cement trade is expanding in the direction of the greatest promise. An examination of the table shows that there were relatively large increases in exports to Brazil, British Guiana, Barbados, Jamaica, Trinidad and Tobago Islands, Chile, the Dutch West Indies, Ecuador, Mexico, Peru, Salvador, and Uruguay. The total increase in exports would have been greater had not exports to Canada, Cuba, Santo Domingo, and a few other countries fallen off. It is of interest to note that the exports to England increased, owing no doubt to a shortage of cement production in England caused by the diversion of labor to military service and the manufacture of munitions.

The following table gives the quantity and value of all classes of hydraulic cement exported during the years 1900–1915, inclusive, and the proportion of exports to the total quantity of hydraulic cement manufactured in the United States. The exports at present consist almost wholly of Portland cement.

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Hydraulic cement exported, 1900–1915.[a]

Year.	Quantity (barrels).	Value.	Percentage of total quantity.	Year.	Quantity (barrels).	Value.	Percentage of total quantity.
1900	100,400	$225,306	0.6	1908	846,528	$1,249,229	1.6
1901	373,934	679,296	1.9	1909	1,056,922	1,417,534	1.6
1902	340,821	526,471	1.3	1910	2,475,957	3,477,981	3.2
1903	285,463	433,984	.95	1911	3,135,409	4,632,215	3.9
1904	774,940	1,104,086	2.4	1912	4,215,532	6,160,341	5.1
1905	897,686	1,387,906	2.2	1913	2,964,358	4,270,666	3.2
1906	583,299	944,886	1.1	1914	2,140,197	3,088,809	2.4
1907	900,550	1,450,841	1.7	1915	2,565,031	3,361,451	3.0

[a] Statistics compiled from records of Bureau of Foreign and Domestic Commerce, Department of Commerce.

IMPORTS.

The following table shows the quantities of foreign cement imported for consumption into the United States during the years 1878 to 1915, inclusive. Owing to the manner in which statistics of imports are grouped, the quantities given include not only Portland cement but all other hydraulic cements. In recent years, however, most of the total has been Portland cement.

The imports in 1915 were approximately 42,218 barrels, of 380 pounds, valued at $57,174, or about $1.35 a barrel, as compared with 120,906 barrels, valued at $194,053, or $1.60 a barrel, in 1914. The number of barrels given in the following table is slightly in excess of the true quantity. The imports of cement as reported by the Bureau of Foreign and Domestic Commerce are given in pounds and include the weights of barrels, sacks, and other packages. No data are at hand to show what proportion of the imports are received in barrels or in sacks, though it is understood that the greater part of the material is imported in sacks, which of course weigh very little—between 0.5 and 0.6 per cent of the weight of the cement.

The table shows a decline in the imports of foreign cement for the six years ending with 1912, slight increases in 1913 and 1914, and a large decrease in 1915, due probably to the cessation of imports from Belgium and Germany.

Foreign cement imported for consumption, 1878–1915, in barrels of 380 pounds.[1]

1878	92,000	1891	2,988,313	1904	968,409
1879	106,000	1892	2,440,654	1905	896,845
1880	187,000	1893	2,674,149	1906	2,273,493
1881	221,000	1894	2,638,107	1907	2,033,438
1882	370,406	1895	2,997,395	1908	842,121
1883	456,418	1896	2,989,597	1909	443,888
1884	585,768	1897	2,090,924	1910	306,863
1885	554,396	1898	1,152,861	1911	164,670
1886	915,255	1899	2,108,388	1912	68,503
1887	1,514,095	1900	2,386,683	1913	85,470
1888	1,835,504	1901	939,330	1914	120,906
1889	1,740,356	1902	1,963,023	1915	42,218
1890	1,940,186	1903	2,251,969		

[1] Statistics compiled from records of Bureau of Foreign and Domestic Commerce, Department of Commerce.

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PORTLAND CEMENT IN CANADA.

The following extract is quoted from the preliminary report on the mineral production in Canada during the calendar year 1915, issued by the Canada Department of Mines, Mines Branch, February, 1916, pages 24–25:

The general decrease in production of structural materials and clay products which was a feature in 1914 was repeated in 1915.

The total quantity of Portland cement, including natural Portland, made in 1915 was 5,153,763 barrels of 350 pounds each, as compared with 8,727,269 barrels in 1914, a decrease of 3,563,506 barrels, or about 40 per cent.

The total quantity of Canadian Portland cement sold or used during 1915 was 5,681,032 barrels, valued at $6,977,024, or an average of $1.228 per barrel, as compared with 7,172,480 barrels, sold or used in 1914, valued at $9,187,924, or an average of $1.28, showing a decrease in quantity of 1,491,448 barrels, or about 20 per cent.

The total imports of cement in 1915 were 98,664 cwt., equivalent to 28,190 barrels of 350 pounds each, valued at $40,426, or an average of $1.434 per barrel, as compared with imports of 98,022 barrels, valued at $147,158, or an average of $1.50 per barrel in 1914.

The total consumption of cement, therefore, neglecting a small export, was 5,709,222 barrels, as compared with a consumption of 7,270,502 barrels in 1914, showing a decrease of 1,561,280 barrels, or about 21 per cent.

The average price per barrel at the works in 1915 was $1.228, as compared with $1.28 in 1914, $1.27 in 1913, $1.28 in 1912, and $1.34 during 1911 and 1910.

The imports of cement in 1915 included 1,065 barrels, valued at $1,480 from Great Britain, and 27,125 barrels, valued at $38,946 from the United States.

NATURAL CEMENT.

PRODUCTION.

The marketed production of natural cement, including bricklayer's cement, in the United States during 1915 amounted to 750,863 barrels, valued at $358,627, as compared with an output of 751,285 barrels, valued at $351,370, in 1914, a decrease in 1915 of 422 barrels, or 0.05 per cent, in quantity and an increase of $7,257, or about 0.2 per cent, in value. The average price of the natural cement per barrel at the mills in 1915 was 47.8 cents, as compared with 46.8 cents, in 1914.

Natural cement was produced in 1914 and 1915 in 12 plants, distributed in seven States, the plants being located at Binnewater (near Rosendale), Jamesville, and Fayetteville, N. Y.; Siegfried, Pa.; Lisbon, Ohio; Speeds, Ind.; Utica, Ill.; Fort Scott, Kans.; and Austin and Mankato, Minn. The plant at Mankato produces what is called "bricklayer's cement," which is reported to contain more lime than most other kinds of natural cement. In the following table the marketed production of natural cement in 1914 and 1915 is outlined by groups of States:

Natural cement shipped in 1914–15.

State.	1914			1915		
	Producing plants.	Quantity (barrels).	Value.	Producing plants.	Quantity (barrels).	Value.
New York	4	226,737	$111,471	4	229,264	$114,587
Illinois	1			1		
Indiana	1	258,048	110,974	1	232,099	99,415
Ohio	2			2		
Pennsylvania	1			1		
Kansas	1	266,500	128,925	1	289,500	144,625
Minnesota	2			2		
	12	751,285	351,370	12	750,863	358,627

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PUZZOLAN CEMENT.

Puzzolan or slag-lime cement was shipped during 1915 from plants at North Birmingham, Ala., Struthers, Ohio, and Sharon, Pa. The output in 1915 was 42,678 barrels, valued at $39,801, compared with 68,311 barrels, valued at $63,358, in 1914. This represents a decrease in quantity of 25,633 barrels, or nearly 38 per cent and in value of $23,557, or more than 37 per cent. The average price per barrel of Puzzolan cement in 1915 was about 93.3 cents, compared with 92.6 cents in 1914, an increase of 0.7 cent a barrel. The price of this cement, therefore, increased slightly in 1915, and was 7.3 cents higher than that of Portland cement. Puzzolan cement should command a good average price, for a considerable proportion of it is of light color, and nonstaining properties are claimed for it by the manufacturers.

The following table summarizes the number of active plants and the production of puzzolan cement produced during the last five years. Since 1912, inclusive, the quantities represent marketed production or shipments.

Statistics of the puzzolan cement industry, 1911–1915.

	1911	1912	1913	1914	1915
Number of plants reporting production:					
Alabama	1	1	1	1	1
New York [a]	1	1	1	1	.....
Ohio	1	1	1	1	1
Pennsylvania	1	1	1	1	1
	4	4	4	4	3
Production in barrels	93,230	91,864	107,313	68,311	42,678
Total value	$77,786	$77,363	$97,663	$63,358	$39,801

[a] Includes production of Collos cement, 1911–1914.

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SAND AND GRAVEL.

By R. W. STONE.

TRADE CONDITIONS.

Depression in business during the early part of 1915 and heavy rainfall in some parts of the country account in part for the slight falling off in total production of sand and gravel in 1915. A tabulation of reports on conditions in the sand industry in the principal producing States follows:

Firms reporting condition of sand and gravel industry in principal producing States in 1915 in comparison with 1914.

State.	Better.	Same.	Worse.
Illinois	29	17	22
Indiana	37	13	25
Michigan	68	49	60
New York	29	23	22
Ohio	56	28	47
Pennsylvania	62	33	43
	281	163	219

This table shows a tendency toward larger business, and the showing is confirmed by the increased quantities of glass, molding, fire, engine, and railroad ballast sand used in 1915 as compared with 1914, as indicated in the tables of production in this report.

The glass business has been very active and continues to be active at this time (June, 1916), partly because of decreased imports and increased exports of glass, which has naturally resulted in a considerable increase in the quantity of glass sand produced. The output of glass sand in 1915 is the largest ever reported by the United States Geological Survey, but the average price per ton is the lowest, having fallen from 97 cents in 1914 to 85 cents in 1915, as shown in the following table:

Glass sand produced in the United States, 1902–1915.

Year.	Quantity (short tons).	Value.	Average price per ton.	Year.	Quantity (short tons).	Value.	Average price per ton.
1902	943,135	$807,797	$0.86	1909	1,104,451	$1,163,375	$1.05
1903	823,044	855,828	1.04	1910	1,461,089	1,516,711	1.04
1904	858,719	798,492	.92	1911	1,538,666	1,543,733	1.01
1905	1,060,334	1,107,730	1.04	1912	1,465,386	1,430,471	.97
1906	1,089,430	1,208,788	1.11	1913	1,791,800	1,895,991	1.06
1907	1,187,296	1,250,067	1.05	1914	1,619,649	1,568,030	.97
1908	1,093,553	1,134,599	1.04	1915	1,884,044	1,606,640	.85

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Molding sand reached its highest production in 1912 and then fell off during the two succeeding years. In 1915, however, there was a marked recovery. Foreign demand for vast supplies of machinery and munitions, requiring the casting of metal compelled the use of a much greater quantity of molding sand in 1915 than in 1914.

Molding sand produced in the United States, 1904–1915.

Year.	Quantity (short tons).	Value.	Average price per ton.	Year.	Quantity (short tons).	Value.	Average price per ton.
1904	3,439,214	$2,125,370	$0.62	1910	3,636,167	$2,431,254	$0.67
1905	3,084,098	2,102,423	.68	1911	3,376,717	2,132,469	.63
1906	3,371,103	2,063,151	.61	1912	4,485,380	2,718,726	.61
1907	3,682,494	2,460,754	.67	1913	3,563,583	2,230,217	.63
1908	1,980,677	1,342,802	.67	1914	2,751,209	1,756,383	.64
1909	3,122,806	2,146,220	.68	1915	3,585,746	2,123,203	.59

For the same reason the quantity of fire and furnace sand required for lining furnaces, for ladles used to contain molten metal, and for making runners for casting pig iron was 65 per cent greater in 1915 than in 1914. There was a decrease in the average price per ton, however, from 59 cents in 1914 to 34 cents in 1915.

PRODUCTION.

The following tables have been prepared by Mrs. L. L. Kimball, statistical clerk, from reports received from thousands of producers throughout the United States:

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Sand and gravel produced in the United States in 1914 and 1915.

1914.

State.	Glass sand.		Molding sand.		Building sand.		Grinding and polishing sand.		Fire and furnace sand.		Engine sand.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama			92,551	$43,702	152,800	$51,792	8,052	$4,104	22,135	$6,450	12,040	$3,127
Arizona					(a)	(a)						
Arkansas			(a)	(a)	90,689	37,625					(a)	(a)
California	(a)	(a)	5,985	5,562	279,723	85,057	196,263	42,701	(a)	(a)	16,951	2,538
Colorado			(a)	(a)	28,275	8,460			(a)	(a)	5,460	2,490
Connecticut			(a)	(a)	22,575	7,825	(a)	(a)				
Delaware			(a)	(a)					(a)	(a)		
District of Columbia					(a)	(a)						
Florida			(a)	(a)	47,572	36,138					(a)	(a)
Georgia	(a)	(a)	10,427	6,247	200,309	51,782	2,230	815	14,600	4,360	5,032	865
Hawaii					(a)	(a)						
Idaho					(a)	(a)						
Illinois	339,551	$246,803	347,543	200,011	1,196,873	383,209	58,351	38,780	60,674	24,569	93,299	12,239
Indiana	36,977	14,138	311,663	83,733	1,873,953	467,691					49,174	9,238
Iowa	(a)	(a)	1,522	2,365	898,561	272,445	(a)	(a)	(a)	(a)	13,119	3,250
Kansas					992,462	310,547	(a)	(a)			29,458	8,631
Kentucky	(a)	(a)	39,493	26,348	435,641	237,639	(a)	(a)	2,294	1,643	11,807	4,315
Louisiana	(a)	(a)			232,874	76,564					5,085	1,730
Maine					(a)	(a)						
Maryland	(a)	(a)	(a)	(a)	445,092	145,827	(a)	(a)			19,484	18,390
Massachusetts	(a)	(a)	12,452	7,487	318,021	162,860	(a)	(a)	(a)	(a)	(a)	(a)
Michigan	26,035	32,593	53,400	36,583	1,088,650	360,152	(a)	(a)			6,357	1,066
Minnesota			26,270	24,291	315,303	116,191	(a)	(a)	(a)	(a)	(a)	(a)
Mississippi			(a)	(a)	92,567	35,428					45,887	9,398
Missouri	160,190	112,484	53,837	26,656	1,788,277	541,741	102,568	54,263	4,486	1,800	43,619	15,872
Montana			(a)	(a)	3,246	4,005						
Nebraska					696,155	113,841					14,069	1,945
Nevada											(a)	(a)
New Hampshire												
New Jersey	83,927	62,595	376,605	237,788	1,704,011	394,092	21,137	23,207	40,454	33,367	62,534	21,849
New Mexico					(a)	(a)					(a)	(a)
New York	(a)	(a)	428,121	308,324	3,887,515	920,909			16,377	7,861	23,649	10,933
North Carolina			(a)	(a)	31,743	15,468						
North Dakota					12,335	5,600						
Ohio	138,565	131,766	547,398	417,314	1,746,457	660,537	24,343	45,193	35,157	30,488	73,255	26,447
Oklahoma	(a)	(a)			898,452	435,313					4,858	1,362

a Included in "Concealed totals."

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Sand and gravel produced in the United States in 1914 and 1915—Continued.

1914—Continued.

State.	Glass sand.		Molding sand.		Building sand.		Grinding and polishing sand.		Fire and furnace sand.		Engine sand.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Oregon					120,856	51,809						
Pennsylvania	512,718	611,173	370,915	280,933	2,066,256	857,305	418,072	295,963	91,519	61,085	409,875	109,348
Rhode Island					(a)	(a)						
South Carolina	(a)	(a)	1,066	1,640	1,480	530	(a)	(a)				
South Dakota			(a)	(a)	25,578	10,686					(a)	(a)
Tennessee	(a)	(a)	6,579	4,021	266,719	123,287	5,610	2,527	11,814	2,544	64,707	15,808
Texas	3,500	3,500	5,120	4,785	371,631	158,587	(a)	(a)	1,588	1,088	9,513	4,698
Utah					1,548	666						
Vermont					4,076	1,368	103,461	9,780				
Virginia	(a)	(a)	15,532	11,128	254,414	110,946	(a)	(a)	(a)	(a)	37,035	4,943
Washington					283,188	67,983						
West Virginia	233,024	269,602	(a)	(a)	251,278	108,112	(a)	(a)	(a)	(a)	96,675	46,578
Wisconsin	(a)	(a)	37,528	21,303	760,740	216,915	(a)	(a)			44,660	4,714
Wyoming					(a)	(a)						
Concealed totals	85,162	83,376	7,202	6,162	96,067	41,842	144,784	135,055	17,462	12,212	65,188	25,774
	1,619,649	1,568,030	2,751,209	1,756,383	24,003,962	7,688,774	1,084,871	652,388	318,560	187,467	1,262,790	367,548

State.	Paving sand.		Railroad ballast sand.		Other sands.		Gravel.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	5,849	$4,538			10,112	$9,813	527,891	$138,693	831,430	$262,219
Arizona									(a)	(a)
Arkansas	(a)	(a)			(a)	(a)	673,924	278,876	789,371	325,360
California	106,578	26,714			23,234	8,384	3,258,718	595,449	3,900,540	777,334
Colorado							7,610	3,310	41,614	14,781
Connecticut	(a)	(a)			(a)	(a)			24,343	8,128
Delaware									(a)	(a)
District of Columbia							(a)	(a)	(a)	(a)
Florida	29,000	7,000	(a)	(a)			98,435	10,637	177,241	54,120
Georgia	5,610	1,400			4,973	2,286	12,244	7,875	260,425	80,130
Hawaii					(a)	(a)			(a)	(a)

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Idaho							(a)	(a)	(a)	(a)	
Illinois	121,812	39,851			522,808	120,635	4,955,219	793,422	7,696,130	1,359,519	
Indiana	158,443	55,290	77,362	$6,485	119,041	27,930	4,184,093	602,533	6,810,706	1,267,038	
Iowa	201,900	64,340	37,749	3,115	6,518	2,444	1,087,967	205,320	2,203,254	556,868	
Kansas	137,582	37,206	(a)	(a)	12,497	3,259	160,283	19,512	1,347,394	381,065	
Kentucky	21,653	14,272			226,239	36,393	815,796	208,770	1,563,498	539,335	
Louisiana	(a)	(a)	29,061	4,250	(a)	(a)	738,510	190,717	1,051,930	284,297	
Maine							(a)	(a)	(a)	(a)	
Maryland	327,750	76,212			(a)	(a)	760,204	268,338	1,571,124	523,720	
Massachusetts	78,380	33,161	(a)	(a)	11,701	3,805	177,642	50,795	645,773	287,218	
Michigan	320,322	74,866	7,565	781	10,336	2,437	2,140,359	530,338	3,757,979	1,143,771	
Minnesota	36,458	15,666	22,950	14,900	33,344	9,698	637,900	236,704	1,074,436	417,979	
Mississippi			(a)	(a)			1,500,291	354,355	2,144,267	499,726	
Missouri	30,327	6,485	(a)	(a)	(a)	(a)	1,321,839	257,827	3,528,678	1,020,908	
Montana	(a)	(a)					13,310	11,970	17,864	17,075	
Nebraska	5,259	610	(a)	(a)	(a)	(a)	88,026	16,435	859,962	141,319	
Nevada							(a)	(a)	(a)	(a)	
New Hampshire							670,000	112,500	670,000	112,500	
New Jersey	110,260	39,902			61,869	59,089	2,204,880	672,433	4,665,677	1,544,322	
New Mexico							(a)	(a)	(a)	(a)	
New York	82,725	34,148	392,968	46,530	78,555	20,702	2,149,310	891,762	7,070,320	2,250,169	
North Carolina			(a)	(a)			311,059	42,438	492,092	72,989	
North Dakota							10,575	5,725	23,210	11,325	
Ohio	407,025	134,370			120,874	56,183	2,417,805	654,833	5,510,879	2,157,131	
Oklahoma			(a)	(a)	35,421	16,083	505,737	225,559	1,477,618	713,117	
Oregon	3,368	2,607	(a)	(a)	533,967	197,790	611,821	137,221	1,271,362	390,177	
Pennsylvania	625,171	235,326			584,900	98,979	1,766,651	387,845	6,866,077	2,937,957	
Rhode Island							(a)	(a)	(a)	(a)	
South Carolina					(a)	(a)	29,927	4,995	33,788	8,480	
South Dakota	(a)	(a)	(a)	(a)	2,026	1,263	196,909	25,808	232,395	40,215	
Tennessee	6,489	2,484	238,431	44,419	51,715	21,644	445,504	183,296	1,097,720	400,182	
Texas	46,460	14,315	59,583	17,466			1,183,646	433,399	1,681,379	638,026	
Utah	44,445	11,300	5,100	2,500			184,763	45,162	235,856	59,628	
Vermont							822	390	108,359	11,538	
Virginia	(a)	(a)	(a)	(a)	(a)	(a)	294,398	87,379	639,382	229,595	
Washington	363,745	86,796	(a)	(a)			457,137	162,183	1,178,330	324,628	
West Virginia	44,617	17,819					455,804	125,618	1,106,742	390,391	
Wisconsin	222,298	71,560	408,378	41,808	825,118	69,080	1,294,393	343,230	3,594,336	768,996	
Wyoming							719,441	48,245	718,914	48,595	
Concealed totals	36,645	13,761	837,282	140,396	55,988	14,876	142,215	26,205	258,840	75,133	
	3,580,171	1,121,999	2,116,429	322,740	3,331,236	782,773	39,212,858	9,398,897	79,261,735	23,846,999	

a Included in "Concealed totals."

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Sand and gravel produced in the United States in 1914 and 1915—Continued.

1915.

State.	Glass sand.		Molding sand.		Building sand.		Grinding and polishing sand.		Fire and furnace sand.		Engine sand.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama			169,663	$59,862	157,581	$51,788	(a)	(a)			6,942	$1,779
Arizona					(a)	(a)						
Arkansas	(a)	(a)	(a)	(a)	76,334	33,749						
California	(a)	(a)	48,154	18,393	440,160	140,035	(a)	(a)	(a)	(a)	54,179	6,501
Colorado					(a)	(a)			(a)	(a)	(a)	(a)
Connecticut			(a)	(a)	18,749	4,782	(a)	(a)				
Delaware			(a)	(a)					(a)	(a)		
District of Columbia					(a)	(a)						
Florida					73,916	21,830	(a)	(a)			(a)	(a)
Georgia	(a)	(a)	3,898	2,883	527,258	163,932	(a)	(a)			1,865	390
Hawaii					(a)	(a)						
Idaho												
Illinois	566,128	$299,286	383,185	195,992	1,600,521	472,654	(a)	(a)	(a)	(a)	73,427	14,677
Indiana	(a)	(a)	148,745	36,823	1,620,851	377,343	(a)	(a)	(a)	(a)	153,316	21,989
Iowa	(a)	(a)	(a)	(a)	912,040	262,587			(a)	(a)	30,249	9,353
Kansas					893,937	267,322					66,568	20,388
Kentucky	(a)	(a)	28,815	27,630	413,610	176,792	(a)	(a)	(a)	(a)	7,928	2,896
Louisiana					(a)	(a)					(a)	(a)
Maine					(a)	(a)						
Maryland	(a)	(a)	(a)	(a)	628,460	186,327	(a)	(a)			22,568	19,303
Massachusetts	(a)	(a)	14,196	6,590	377,582	159,997	(a)	(a)	(a)	(a)	(a)	(a)
Michigan	(a)	(a)	82,666	25,998	843,887	236,956	(a)	(a)	(a)	(a)	70,077	2,794
Minnesota			14,150	10,519	319,339	109,119	(a)	(a)			(a)	(a)
Mississippi			(a)	(a)	48,615	16,569					(a)	(a)
Missouri	145,920	91,380	41,284	18,852	794,398	248,225	(a)	(a)	(a)	(a)	67,229	19,970
Montana					6,737	5,825						
Nebraska					572,832	115,356					23,120	4,884
Nevada												
New Hampshire												
New Jersey	(a)	(a)	509,187	331,792	1,838,647	421,927	79,453	$48,236	53,113	$37,184	49,676	20,133
New Mexico					(a)	(a)						
New York			681,129	462,013	3,370,109	788,115	(a)	(a)	(a)	(a)	353,597	108,095
North Carolina					208,398	60,770						
North Dakota					12,750	5,775						
Ohio	128,758	129,528	705,679	503,583	2,251,369	710,139	30,381	29,215	51,882	48,857	66,086	28,268
Oklahoma	(a)	(a)			(a)	(a)					(a)	(a)
Oregon					107,153	69,245					(a)	(a)
Pennsylvania	455,112	550,706	554,809	342,782	2,395,299	931,140	232,731	172,806	82,211	59,134	246,220	139,223

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Rhode Island					(a)	(a)						
South Carolina	(a)	(a)	(a)	(a)	27,881	8,745						
South Dakota					15,833	8,546					(a)	(a)
Tennessee			25,313	11,586	279,892	119,830	(a)	(a)	(a)	(a)	50,848	12,425
Texas			(a)	(a)	356,405	126,437			(a)	(a)	12,113	2,230
Utah					1,656	595	(a)	(a)			(a)	(a)
Vermont			(a)	(a)	(a)	(a)	72,485	22,337				
Virginia	(a)	(a)	36,629	8,645	244,146	86,151	2,440	765	(a)	(a)	46,247	6,881
Washington					197,625	51,471					4,370	2,365
West Virginia	264,076	280,702	(a)	(a)	135,113	83,821	(a)	(a)			77,794	36,259
Wisconsin			126,675	50,661	678,585	169,166	(a)	(a)			43,424	6,202
Wyoming												
Concealed totals	324,050	255,038	11,569	8,599	423,758	191,206	552,228	174,154	342,681	36,205	32,358	8,724
	1,884,044	1,606,640	3,585,746	2,123,203	22,921,426	6,884,267	969,718	447,513	529,887	181,380	1,560,201	495,724

a Included in "Concealed totals."

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Sand and gravel produced in the United States in 1914 and 1915—Continued.

1915—Continued.

State.	Paving sand.		Railroad ballast sand.		Other sands.		Gravel.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	(a)	(a)	(a)	(a)	7,294	$2,180	547,656	$116,672	924,701	$242,336
Arizona							(a)	(a)	(a)	(a)
Arkansas			(a)	(a)			831,668	314,003	931,316	352,957
California	173,985	$42,841	45,131	$12,160	59,000	27,571	2,974,090	709,602	3,827,706	977,116
Colorado	(a)	(a)	(a)	(a)			(a)	(a)	(a)	(a)
Connecticut							(a)	(a)	19,350	5,137
Delaware									(a)	(a)
District of Columbia									(a)	(a)
Florida	(a)	(a)	6,470	1,430			16,518	4,495	123,548	34,055
Georgia	(a)	(a)			(a)	(a)	22,848	15,071	572,309	191,447
Hawaii							(a)	(a)	(a)	(a)
Idaho					(a)	(a)	(a)	(a)	(a)	(a)
Illinois	291,436	73,645	(a)	(a)	(a)	(a)	4,424,527	885,548	7,706,012	1,964,569
Indiana	240,053	66,894	1,040,463	76,749	159,950	19,041	2,482,922	501,592	5,998,894	1,235,071
Iowa	293,948	97,008	180,983	25,721	23,967	7,609	1,554,199	313,327	3,002,806	720,795
Kansas	244,103	70,311	(a)	(a)	(a)	(a)	(a)	(a)	1,285,496	378,355
Kentucky	(a)	(a)	(a)	(a)	(a)	(a)	448,807	162,524	944,713	397,764
Louisiana	(a)			(a)	(a)	(a)	(a)	(a)	(a)	(a)
Maine							(a)	(a)	(a)	(a)
Maryland	163,304	71,517			(a)	(a)	854,180	284,410	1,688,427	579,555
Massachusetts	47,230	25,444	(a)	(a)	(a)	(a)	270,906	109,772	747,747	387,371
Michigan	131,466	14,021	(a)	(a)	15,715	2,280	2,457,094	671,970	3,776,726	1,036,739
Minnesota	(a)	(a)	(a)	(a)	(a)	(a)	935,252	175,084	1,508,890	327,975
Mississippi	(a)	(a)	(a)	(a)			991,119	153,627	1,299,813	252,885
Missouri	(a)	(a)	(a)	(a)	(a)	(a)	1,656,745	226,716	2,889,211	675,484
Montana	(a)	(a)			(a)	(a)	7,422	5,500	16,387	13,205
Nebraska	(a)	(a)	71,076	9,161	(a)	(a)	118,970	27,389	1,075,139	200,920
Nevada							17,491	1,775	17,491	1,775
New Hampshire							583,200	77,760	583,200	77,760
New Jersey	160,256	53,559			81,095	22,476	2,112,557	447,388	4,968,104	1,447,557
New Mexico	(a)	(a)					(a)	(a)	(a)	(a)
New York	51,363	21,240					2,828,887	989,801	7,449,807	2,416,522
North Carolina			139,101	40,275			77,241	23,652	424,740	124,697
North Dakota							(a)	(a)	30,240	12,135
Ohio	501,359	194,026	(a)	(a)	94,109	47,617	2,816,132	922,379	6,861,023	2,634,145
Oklahoma			(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Oregon	15,218	14,174	(a)	(a)	283,728	86,612	368,797	118,960	880,633	301,425
Pennsylvania	291,599	106,828	(a)	(a)	86,517	39,470	1,814,902	433,223	6,164,400	2,776,812

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Rhode Island					(a)	(a)	(a)	(a)	(a)	(a)
South Carolina			(a)	(a)	(a)	(a)	(a)	(a)	109,011	21,440
South Dakota	(a)	(a)					239,649	36,826	256,270	45,717
Tennessee	13,815	3,552	(a)	(a)			540,653	203,867	1,015,055	376,826
Texas	11,904	2,950	(a)	(a)	(a)	(a)	1,494,421	393,121	1,912,303	533,808
Utah	(a)	(a)	(a)	(a)	(a)	(a)	251,216	29,772	261,611	32,197
Vermont							(a)	(a)	76,590	23,942
Virginia	(a)	(a)	(a)	(a)	(a)	(a)	519,850	126,801	870,219	234,112
Washington	83,827	27,628	(a)	(a)			478,707	129,016	772,629	211,480
West Virginia	69,598	27,230			(a)	(a)	114,273	43,016	723,354	479,685
Wisconsin	206,094	67,340	149,535	9,186	89,410	37,069	1,567,840	349,941	2,862,036	689,915
Wyoming							(a)	(a)	526,837	49,439
Concealed totals	391,150	97,138	1,056,007	175,443	208,465	65,103	1,551,719	443,791	1,496,559	636,492
	3,381,717	1,077,346	2,688,766	350,125	1,109,250	357,028	37,972,548	9,598,391	76,603,303	23,121,617

a Included in "Concealed totals."

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IMPORTS.

Sand valued at $96,754 was imported into the United States in 1915, as compared with imports valued at $139,675 in 1914, and at $172,257 in 1913. This is largely building sand brought to the United States as ballast or from Canada as a near source of supply, but it includes a small quantity of French molding sand imported for making fine bronze castings.

GLASS-SAND LOCALITIES.

Because of the increase in the glass business and of the consequent large demand for glass sand, two lists of glass-sand localities in the United States are given herewith.

Localities where glass sand was reported as produced in 1915.

Arkansas: Ruddells.
California: Ione and Lake Majella.
Georgia: Howard and Lumber City.
Illinois: Millington, Oregon, and Ottawa.
Indiana: Coxville and Michigan City.
Iowa: Clayton.
Kentucky: Olive Hill.
Maryland: Robinson.
Massachusetts: Cheshire.
Michigan: Rockwood and Steiner.
Missouri: Crystal City, Klondike, Pacific, St. Louis, and Silica.
New Jersey: Cedarville, Millville, Penbryn, South Vineland, and Williamstown Junction.
Ohio: Austintown, Barberton, Dayton, Hartford, Howard, Macedonia, Massillon, Rockbridge, Silica, and Tobasco.
Oklahoma: Hickory, Oklahoma City, and Roff.
Pennsylvania: Berne, Bingham, Caln, Daguscahonda, Derry, Dunbar, Falls Creek, Hamilton, Kennerdell, Mapleton, Newton, Reading, Ridgeway, St. Marys, and Vineyard.
South Carolina: Blackville.
Virginia: Bristol and Mendota.
West Virginia: Berkeley Springs, Buckhannon, Hinton, Independence, Sturgisson, Terra Alta (Holmes Station), and West Berkeley.

Localities where glass sand occurs.

Alabama: Jefferson County, from crushed sandstone at Gates City; Etowah County, Gadsen.
Arkansas: Izard County, Guion and Ruddells; Jefferson County, Pine Bluff; St. Peter sandstone along valley of White River from Batesville nearly to Fayetteville, probably will make excellent glass sand.
California: Alameda County, Tesla; Amador County, Ione; Los Angeles County, Palmdale; Monterey County, Pacific Grove; San Joaquin County, near Stockton.
Delaware: Newcastle County, Christiana.
Florida: Escambia County, dunes at Pensacola; probably occurs at other places in State.
Georgia: Crawford County, Zenith; Montgomery County, Lumber City; Richmond County, dredged from Savannah River at Augusta; Taylor County, Butler, and Howard.
Illinois: Bond County, Greenville; Calhoun County, Cap au Iris; Kendall County, Millington; LaSalle County, important quarries in St. Peter sandstone at Ottawa, Utica, and Wedron; Lee and Ogle counties, along Rick River.
Indiana: Blackford County, Montpelier; Floyd County, New Albany; Fountain County, near Hillsboro; Greene County, Johnson; Hamilton County, Lapel; Harrison County, Depauw; La Porte County, Michigan City; Madison County, Pendleton; Martin County, Loogootee; Parke County, Coxville; White County, Wolcott.

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Iowa: Allamakee County, abundant in St. Peter sandstone; Clayton County, Clayton; Johnson County, River Junction; Linn County, Cedar Rapids.
Kansas: Montgomery County, near Caney and Independence, friable sandstone in Buxton formation in suitable quality; Wilson County, Fredonia.
Kentucky: Calloway County, in hills bordering Beechy Creek; Carter County, Lawton and Olive Hill; Hardin County, Tip Top; Kenton County, Ludlow.
Maine: Knox County, Camden; Waldo County, Liberty.
Maryland: Anne Arundel County, Robinson, Magothy River; Baltimore County, Catonsville; Washington County, Rock Forge; also in Cecil, Harford, and Kent counties.
Massachusetts: Berkshire County, made from granular quartzite at Cheshire and Washington; Dukes County, Tertiary sands at Gay Head and Marthas Vineyard.
Michigan: Monroe County, near Steiner; Wayne County, near Rockwood.
Mississippi: Hinds County, at Byram, Jackson, and elsewhere along Pearl River; Jackson County, Horn Island; Tishomingo County, large deposit 1 mile from Tennessee River.
Missouri: St. Peter sandstone suitable for glass sand outcrops in a belt from a thin strip to 20 miles wide along Mississippi River from Ralls County to Cape Girardeau County and also up Missouri River as far as Calloway County. Important quarries: Franklin County, Becker, Gray Summit, and Pacific; Jefferson County, Crystal City and Silica; St. Charles County, Klondike.
Nevada: Ormsby County, 4 miles from Carson.
New Jersey: Camden County, Penbryn, Williamstown Junction, and Wilton; Cumberland County, Cedarville, Millville, and South Vineland; Gloucester County, Williamstown; Middlesex County, Jamesburg.
New York: Oneida County, Durhamville; Oswego County, Cleveland and Minetto; Schenectady County, Niskayuna; Ulster County, sandstone at Ellenville.
Ohio: Sandstones of Silurian or Carboniferous age quarried and crushed: Erie County, Sandusky; Hocking County, Rockbridge; Knox County, Howard; Licking County, Toboso; Lucas County, Sylvania; Mahoning County, Austintown; Muskingum County, Zanesville; Perry County, Chalfants; Stark County, Massillon; Summit County, Barberton, Macedonia, and Warwick; Trumbull County, Hartford and Niles; Tuscarawas County, Dundee.
Oklahoma: Arbuckle Mountains, sandstone of Simpson formation; southeastern Oklahoma north of Red River, Trinity sand; Cherokee County, St. Peter sandstone near Tahlequah.
Pennsylvania: Berks County, Berne and Reading; Chester County, Caln; Clearfield County, Falls Creek; Elk County, Daguscahonda, Ridgeway, and St. Marys; Fayette County, Dunbar, and along Monongahela River near Belle Vernon; Huntingdon County, Mapleton; McKean County, Bingham; Mifflin County, Hamilton, Newton, and Vineyard; Venango County, Kennerdell and Rochmere Station (near Oil City); Westmoreland County, Derry.
South Carolina: Barnwell County, Blackville and Ulmers; Clarendon County, Pee Dee.
South Dakota: Meade County, Unkpapa sandstone on Elm Creek.
Tennessee: Anderson County, Coal Creek; Benton County, abundant saccaroidal sandstone; Blount County, Chilhowee; Hardeman County, Saulsbury; Knox County, Knoxville; Montgomery County, abundant friable sandstone; Sullivan County, 20 miles from Bristol.
Texas: Grayson County, Denison.
Vermont: Bennington County, East Dorset, disintegrated quartz once used; Windsor County, Plymouth.
Virginia: Fine white sand of suitable quality occurs along eastern edge of middle Valley region—Amherst County, Stapleton Mills; Augusta County, Greenville; Rockbridge County, Balcony Falls, along west base of Blue Ridge; Roanoke County, Catawba Mountain, 9 miles northwest of Salem; Washington County, Bristol and Mendota.
West Virginia: Monongalia County, Sturgisson; Morgan County, Berkeley Springs; Preston County, Holmes Station, near Independence; Randolph County, Silica; Taylor County, Grafton; Upshur County, Buckhannon, Craddock.
Wisconsin: Columbia County, Portage; Monroe County, Tomah; Rock County, Beloit; St. Peter sandstone in many localities as at Waukau, Winnebago County.
Wyoming: Albany County, soft sandstone, 3 miles east of Laramie.

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WEIGHT OF SAND AND GRAVEL PER CUBIC YARD.

The production of sand and gravel is reported by the Survey in short tons, but some of it is reported to the Survey in cubic yards, so that it has been necessary to make inquiry of the producers as to the weight of the cubic yard of sand and gravel sold by them in order to convert their figures into tons. The result of this inquiry is a determination for the whole country of an approximate average weight per cubic yard of 2,665 pounds for sand and of 2,820 pounds for gravel. According to the reports of 670 producers of sand and of 560 producers of gravel who reported to the Geological Survey in cubic yards instead of tons, the weight of a cubic yard of sand varies from 2,200 pounds to 4,000 pounds and the weight of a cubic yard of gravel from 2,200 pounds to 4,200 pounds. Any weight above 3,300 pounds a cubic yard for sand is very unusual, for of the 670 producers replying to the question, only 12 reported above that weight and only 22 reported above 3,000 pounds. It is surmised that the sands reported as weighing over 3,000 pounds were weighed wet, or that the reported weight was only a guess, or that the composition was unusual; for a cubic yard of pure quartz closely packed should weigh 3,240 pounds.

It may be that many of the weights reported to the Survey are guesses and not actual determinations, but even if this is so the expression of opinion of several hundred producers should give a very fair average weight. The average weights of sand and gravel in those States in which 10 or more producers reported figures are as follows:

Reported weights of sand and gravel to the cubic yard, in pounds.

State.	Sand.	Gravel.	State.	Sand.	Gravel.
Alabama	2,505	2,790	Missouri	2,680	2,840
California	2,645	2,895	New Jersey	2,600	2,730
Florida	2,605	2,680	New York	2,590	2,760
Illinois	2,820	3,005	Ohio	2,700	2,830
Indiana	2,700	2,945	Oregon	2,620	2,880
Iowa	2,720	2,850	Pennsylvania	2,500	2,680
Kentucky	2,580	2,830	Texas	2,695	2,910
Massachusetts	2,710	2,810	Washington	2,930	3,065
Michigan	2,895	2,985	West Virginia	2,570	2,780
Minnesota	2,865	2,890	Wisconsin	2,800	2,970

It is noticeable that the highest average weights for both sand and gravel are shown by Illinois, Michigan, Minnesota, Washington, and Wisconsin. If there is any special significance to this it is not apparent to the writer.

The figures given above for Illinois, Indiana, Iowa, Michigan, New York, Ohio, and Wisconsin are averages from the reports of 30 to 65 producers; the averages for the other States are from fewer producers. A cubic yard of sand of spherical grains of uniform size and a cubic yard of gravel of the same mineral composition and consisting of round pebbles, all of the same size, should have the same weight, for the pore space would be equal and about 27 per cent of the volume.

There are two principal reasons, however, why gravel weighs more than the same volume of sand. One is the difference in mineral com-

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position, and the other the greater variation in size of component parts. Gravel is commonly composed of rock fragments which contain quartz, feldspar, and ferromagnesian minerals; quartz is the least soluble of these and forms the greater part of most sands, the heavier and more easily disintegrated minerals being reduced to silt. Sand, therefore, as a usual thing, is lighter than the gravel from which it is derived because the lighter mineral forms a greater percentage of the whole. Second, sand is comparatively even-grained and, therefore, has considerable pore space, while the ordinary run of unsized gravel has a wide range in size of individual pebbles, which results in a considerable reduction in pore space. It is largely the lack of close sizing that gives ordinary gravel a greater weight per unit of volume than the same volume of sand.

In connection with the discussion now going on among dealers as to the advisability or advantage of selling sand and gravel by weight rather than by volume, attention is directed to the results of laboratory tests on sands derived from 19 different localities in western Washington, kindly furnished to the Survey by the analyst, Mr. R. J. Borhek, of Tacoma, Wash. Samples of sand were thoroughly dried, poured into a cylinder having a capacity of one-fifth of a cubic foot, shaken until settling ceased, and then weighed. The weights computed for a cubic yard range from 2,692 to 3,164 pounds, the average being 3,020 pounds for 19 samples. On comparing this with the average of 2,930 pounds per cubic yard derived from the reports of 10 dealers in the same area, whose estimates ranged from 2,500 to 3,200 pounds per cubic yard, the suggestion at once arises that the consumer who buys sand by the cubic yard may be getting nearly 100 pounds more per yard than the dealer estimates. It is obvious, however, that the consumer is at a disadvantage in purchasing sand by weight if the material has not been dried and kept under cover, and most sand is not so treated. A yard of building sand would weigh more when it was just pumped from the river than after it had drained and dried on the dock, or more after a shower than after a day in the sun. Furthermore, weighing causes a slight loss of time in delivery. The sale of sand and gravel by the yard, on the other hand, is haphazard, for wagon boxes vary in capacity, the exact capacity is not known to the loader, and one load may be heaped higher than another.

CHATS.

The tables of production given above do not include a considerable quantity of chats or tailings from the Missouri zinc mines. This waste product, which is used on roads, has a nominal value of 10 cents a ton, or the cost of loading. The shipment of chats in Missouri in 1915, as reported by the Missouri Bureau of Geology and Mines, was 2,309,191 tons, compared with 2,270,771 tons in 1914.

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PHOSPHATE ROCK.

By W. C. PHALEN.[1]

PHOSPHATE ROCK MARKETED.

The phosphate rock marketed in the United States in 1915 amounted to 1,835,667 long tons, valued at $5,413,449. Compared with the production of 1914, which was 2,734,043 long tons, valued at $9,608,041, this was a decrease of 898,376 long tons, or nearly 33 per cent, and in value of $4,194,592, or nearly 44 per cent. The disproportionate decrease in value is brought out in the average prices per ton given in the table below.

The phosphate rock industry during 1915 was in the same bad condition, especially in Florida, that prevailed in 1914. Soon after the outbreak of the war in Europe the phosphate-mining companies of Florida, including not only those that produce the higher-grade rock for export but also those that supply the domestic trade, either curtailed production very materially or suspended mining.

Shipments of phosphate rock to Germany, hitherto a large consumer, have almost entirely ceased, and those to other European countries have been seriously interrupted. Business has been greatly retarded by lack of steamers and by increased freight rates, and there seems to be little likelihood of improvement till peace has been declared.

The great demand for sulphuric acid, especially toward the end of 1915, has also been a factor in curtailing the production of domestic phosphate rock. Acid prices have ranged so high that the manufacture of acid phosphate has shown a tendency to decline.

If the demands of German agriculture return to a normal condition after the war, and there is no apparent reason why they should not, the present lack of phosphate fertilizer in Germany, due in large part to stoppage of imports of phosphate rock, will probably be made up in efforts to bring the soil back to its former productive state. These efforts should create an increased demand for phosphate rock and tend to recoup to some extent the losses suffered by American producers, who will probably be given the preference over French and English producers.

[1] The statistics in this chapter were prepared by Miss L. M. Jones.

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Phosphate rock sold in the United States, 1914–15.

State.	1914			1915		
	Quantity (long tons).	Value.	Average price per ton.	Quantity (long tons).	Value.	Average price per ton.
Florida:						
Hard rock	309,689	$1,912,197	$6.17	50,130	$265,738	$5.30
Land pebble	[a] 1,829,202	5,442,547	2.98	1,308,481	3,496,501	2.67
River pebble	(a)	(a)				
Total	2,138,891	7,354,744	3.44	1,358,611	3,762,239	2.77
South Carolina:						
Land rock	106,919	415,039	3.88	83,460	310,850	3.72
Tennessee:						
Brown rock	483,203	1,822,770	3.77	[b] 389,759	1,327,747	3.41
Blue rock	0	0				
White rock						
Total	483,203	1,822,770	3.77	[b] 389,759	1,327,747	3.41
Western States	[c] 5,030	15,488	3.08	[c] 3,837	12,613	3.29
Grand total	2,734,043	9,608,041	3.51	1,835,667	5,413,449	2.95

[a] Small quantity of river pebble included with land pebble.
[b] Includes a very small quantity of rock from Arkansas.
[c] Includes, 1914: Idaho and Wyoming; 1915: Idaho, Utah, and Wyoming.

The total production of phosphate rock in the United States from the beginning of the industry in 1867 to 1915 is shown in the following table. Up to 1885 the figures are for the year ending May 31. The figures given for 1885 represent the output for 19 months, as follows: June 1, 1884, to May 31, 1885, 395,403 tons, $2,339,468; June 1 to December 31, 1885, 277,789 tons, $1,805,629. Figures for subsequent years represent calendar years.

Phosphate rock sold in the United States, 1867–1915.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1867-1880	1,449,076	$7,248,380	1899	1,515,702	$5,084,076
1881	266,734	1,980,259	1900	1,491,216	5,359,248
1882	332,077	1,992,462	1901	1,483,723	5,316,403
1883	378,380	2,270,280	1902	1,490,314	4,693,444
1884	431,779	2,374,784	1903	1,581,376	5,319,294
1885	673,192	4,145,097	1904	1,874,428	6,580,875
1886	430,549	1,848,939	1905	1,947,190	6,763,403
1887	480,558	1,836,818	1906	2,080,957	8,579,437
1888	451,567	2,089,552	1907	2,265,343	10,653,558
1889	545,745	2,920,276	1908	2,386,138	11,399,124
1890	510,499	3,213,795	1909	2,338,364	10,796,456
1891	587,988	3,651,151	1910	2,654,988	10,917,000
1892	681,571	3,296,127	1911	3,053,279	11,900,693
1893	941,368	4,136,070	1912	2,973,332	11,675,774
1894	996,949	3,479,547	1913	3,111,221	11,796,231
1895	1,038,551	3,606,094	1914	2,734,043	9,608,041
1896	930,779	2,808,372	1915	1,835,667	5,413,449
1897	1,039,345	2,673,202			
1898	1,308,885	3,453,460		50,293,573	200,826,171

In connection with this table the following historical notes are of interest:

The history of phosphate mining in the United States began in 1867, when the Charleston, S. C., Mining & Manufacturing Co. was organized

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to work the deposits along Ashley River, near Tenmile Hill, above Charleston, S. C. The first small cargoes were shipped in April, 1868. Land rock was the kind first mined in South Carolina, river rock not being mined for market until 1870.

Florida rock was first mined in 1888 or 1889, and the first cargo was shipped in April, 1890.[1] The production in Florida exceeded that in South Carolina in 1894. Tennessee rock was put on the market about 1893. Its production increased rapidly and in 1899 exceeded that of South Carolina. Until about 1885 South Carolina furnished more than 95 per cent of the phosphate rock marketed in the United States. In 1915 its production was only 4.5 per cent of the total.

The first of the western phosphate fields was discovered in 1906, and although for economic reasons these fields have not yet made a large output, it is probable that most of the production of the future will come from the West, where the principal deposits are on public lands. The slow development of the western phosphate fields is due to their remoteness from centers of consumption, lack of transportation facilities, and high freight rates.

Since the western fields were discovered they have been systematically investigated by the United States Geological Survey, and some of the results have been published. During its field studies the Survey has discovered extensive additional deposits of great value and has much increased the knowledge of the area and quantity of minable phosphate rock in the West.

PHOSPHATE ROCK MINED.

The quantity of phosphate rock mined in 1915 was 1,935,341 long tons. Compared with the quantity mined in 1914, which was 2,649,174 long tons, this was a decrease of about 27 per cent. In Florida the decrease amounted to nearly 31 per cent; in Tennessee it was about 9 per cent; in South Carolina, 31 per cent; and in the Western States, 25 per cent. No rock was reported mined in Kentucky in 1915.

STOCK ON HAND.

Stocks on hand at the close of 1915 showed an increase for the entire country amounting to nearly 11 per cent. In Florida the increase amounted to 14 per cent; in Tennessee it was 6 per cent; in South Carolina there was a decrease of 34 per cent.

PRODUCTION BY STATES.

FLORIDA.

In 1915 Florida, the leading State in the production of phosphate rock, marketed 1,358,611 long tons, valued at $3,762,239, or 74 per cent of all the phosphate rock produced in the United States. Compared with the output in 1914, this was a decrease in quantity of 780,280 long tons, or 36 per cent, and in value of $3,592,505, or 49 per cent. An index of the great falling off in the phosphate-rock trade both in Florida and in the United States is afforded by the fact that the pro-

[1] Millar, C. C. H., Florida, South Carolina, and Canadian phosphates, p. 78, London, 1892.

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duction in this State alone in 1914 far exceeded that of the whole United States in 1915. The phosphate rock produced in Florida consists of hard rock and land pebble. No river pebble was mined or sold in 1915. There was a decrease of 259,559 tons, or 84 per cent, in the hard rock sold and of 520,721 tons, or 28 per cent, in the land pebble. The great decrease in hard rock is due to the fact that this is the variety of rock chiefly exported.

As will be observed from the first table above, average prices per ton were lower than in 1914. Hard rock decreased 87 cents per ton and land pebble 31 cents. The average price per ton for the entire product of the State was 67 cents less than in the preceding year.

The hard rock sold came from Alachua, Citrus, Hernando, Levy, Marion, and Suwanee counties. The land pebble came from Polk and Hillsboro counties.

Phosphate rock sold in Florida, 1911–1915.

Year.	Hard rock.		Land pebble.		Total.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1911	443,511	$2,761,449	[a] 1,992,737	$6,712,189	2,436,248	$9,473,638
1912	493,481	3,293,168	[a] 1,913,418	6,168,129	2,406,899	9,461,297
1913	489,794	2,987,274	[a] 2,055,482	6,575,810	2,545,276	9,563,084
1914	309,689	1,912,197	[a] 1,829,202	5,442,547	2,138,891	7,354,744
1915	50,130	265,738	1,308,481	3,496,501	1,358,611	3,762,239

[a] Includes a small quantity of river pebble.

TENNESSEE.[1]

The production of phosphate rock in Tennessee in 1915 was 389,759 long tons, valued at $1,327,747, or 21 per cent of the entire production of the United States. Compared with the production in 1914, this was a decrease of 93,444 long tons, or 19 per cent in quantity, and of $495,023, or 27 per cent, in value. In spite of the decrease, the proportion of Tennessee's share in the total of the country was 3 per cent larger than in 1914, owing, of course, to the great slump in the production in Florida. The average price per ton of Tennessee phosphate rock decreased 36 cents, compared with 1914. The phosphate rock mined in Tennessee is classified as brown, blue, and white rock. In 1915 brown rock came from Giles, Hickman, and Maury counties, blue rock came from Lewis County, and white rock from Decatur County. Brown rock is the most valuable produced in the State.

[1] The figures given for Tennessee include a small quantity of Arkansas rock—so small, however, as not to affect appreciably the comparisons made.

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Phosphate rock sold in Tennessee, 1911–1915.

Year.	Brown rock.		Blue rock.		Total.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1911	[a] 365,068	$1,450,063	[b] 72,302	$263,954	437,370	$1,714,017
1912	359,692	1,420,726	[b] 63,639	219,750	423,331	1,640,476
1913	[c] 451,559	1,774,392	(d)	(d)	451,559	1,774,392
1914	[c] 483,203	1,822,770	(d)	(d)	483,203	1,822,770
1915	[e] 389,759	1,327,747	(d)	(d)	389,759	1,327,747

[a] Includes a small quantity of rock from Kentucky.
[b] Includes a small quantity of rock from Arkansas.
[c] Includes blue rock.
[d] Included under brown rock.
[e] Includes blue and white rock and a small quantity of rock from Arkansas.

SOUTH CAROLINA.

The production of phosphate rock in South Carolina in 1915 was 83,460 long tons, valued at $310,850. This was a decrease of 23,459 tons, or 22 per cent, in quantity, and of $104,189, or 25 per cent, in value, compared with the output in 1914. Only land rock was mined and marketed, no river rock having been produced for several years. The output of the State in 1915 constituted 4.5 per cent of that of the entire country.

Phosphate rock sold in South Carolina, 1911–1915.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1911	169,156	$673,156	1914	106,919	$415,039
1912	131,490	524,760	1915	83,460	310,850
1913	109,333	440,588			

WESTERN STATES.

The phosphate rock produced in the Western States in 1915 came from Bear Lake County, Idaho; Rich County, Utah; and Lincoln County, Wyo. The western production is as yet insignificant, amounting in 1915 to only 3,837 long tons, valued at $12,613, compared with 5,030 tons, valued at $15,488, in 1914. This output constituted about 0.2 per cent of that of the entire country. The average price per ton of western phosphate rock was $3.29, or 21 cents per ton more than in 1914.

IMPORTS OF FERTILIZER MATERIALS.

The fertilizer materials imported into the United States in 1915 include many compounds containing phosphorus, nitrogen, and potash. Those containing phosphorus include bone ash, guano, basic slag, and crude phosphate rock. The potash fertilizers include various potash salts, kainite, manure salts, and double-manure salts. The nitrogen compounds are chiefly cyanamid, nitrates, and ammonium salts.

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The use of calcium cyanamid, or lime nitrogen, is rapidly increasing. This substance was not separately classified in 1909 but has been itemized since 1910. It is a bluish black odorless material which comes into the trade in powdered form. It contains from 20 to 22 per cent of nitrogen. The plants of the American Cyanamid Co., which manufacture this commodity, are at Niagara Falls, Canada, and have been enlarged from an original capacity per annum of 12,000 tons in 1909 to 64,000 tons in 1914, and the company is now operating at this rate. The product is used by more than 300 fertilizer manufacturers in the United States and is estimated to be now a source of organic nitrogen in about one-quarter of the total ammoniated fertilizer mixtures consumed in the country.

Fertilizers imported and entered for consumption in the United States, 1911–1915.[a]

Fertilizer.	1911		1912		1913		1914		1915	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Apatite	20	$300	100	$1,400	2,962	$22,471	20	$300	.....	.....
Bone dust or animal carbon, and bone ash, fit only for fertilizing	36,856	943,472	117,717	878,686	35,012	851,136	36,000	892,529	21,538	$543,243
Calcium cyanamid or lime nitrogen	5,292	292,496	9,311	493,519	26,729	1,410,248	21,793	1,119,785	30,043	1,322,195
Guano	36,869	774,315	19,128	329,624	16,674	518,429	25,335	761,562	9,874	220,768
Kainit	563,957	2,748,140	511,976	2,386,362	465,336	2,201,730	313,898	1,551,115	6,674	95,440
Manure salts, including double manure salts	159,796	1,660,040	171,757	1,797,057	223,687	2,245,509	168,969	1,846,475	13,753	200,584
Phosphates, crude	16,153	157,394	28,821	231,255	17,121	124,815	15,079	136,526	5,359	50,606
Slag, basic, ground or unground	12,622	87,994	12,596	114,300	13,186	130,455	9,199	105,272	76	1,343
All other substances used only for manure	197,810	4,098,321	127,932	2,660,887	154,729	3,314,460	171,603	3,507,875	72,848	1,535,860
	1,029,375	10,762,472	999,338	8,893,090	955,436	10,819,253	761,896	9,921,439	160,165	3,970,039

[a] The statistics in this table were compiled from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

The above table does not include all the material imported into the United States which goes into the fertilizers manufactured and sold in this country. To the materials listed in the table should be added the potash salts listed as such in the import tables of the Bureau of Foreign and Domestic Commerce, which enter largely into manufactured fertilizer. These salts are potassium chloride and potassium sulphate. Moreover, considerable imported sodium nitrate (Chile saltpeter) is used in the fertilizer industry. A large part of the sodium nitrate imported, however, is converted into nitric acid and nitrates used in the manufacture of gunpowder and other explosives, matches, and pyrotechnic material, in assaying and analytical operations, for curing meats, and for other purposes. The large importation of sodium nitrate is very significant. Sodium nitrate and potash salts are commodities for which the United States in past

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years has been entirely dependent on foreign countries. The production of potash salts, an infant industry in the United States, is described in the chapter of Mineral Resources devoted exclusively to that subject.

Materials entering largely into the fertilizer industry imported for consumption in the United States, 1913–1915.

	1913		1914		1915	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Fertilizers	955,436	$10,819,253	761,896	$9,921,439	160,165	$3,970,039
Potassium chloride	212,170	7,075,745	165,858	5,745,385	57.741	2,296,606
Potassium sulphate	39,597	1,677,429	35,914	1,557,224	11,346	664,484
Sodium nitrate	612,861	21,630,811	545,730	15,204,539	770,628	22,844,746
	1,820,064	41,203,238	1,509,398	32,428,587	999,880	29,775,875

EXPORTS.

The great bulk of the phosphate exported from the United States goes from the Florida field. The marketed production of Florida phosphate rock in 1915 was 1,358,611 long tons, valued at $3,762,239, or $2.77 a ton, whereas the total exports from the United States, which amounted to only 253,549 long tons, were valued at $1,605,639, or $6.33 a ton. As compared with 1914, this was a decrease of 710,565 tons in quantity and of $5,166,013 in value.

Land pebble or lower-grade rock largely predominates in the Florida output, and the average value is in consequence proportionately low. In 1915, as in most other years, the proportion of hard rock in the exported material was greater than in the total production, but during that year, on account of the considerable decrease in the quantity exported, the value of the exports fell below that of the total output in spite of the fact that the price per ton of the exported rock ($6.33) was considerably higher than that of the hard rock ($5.30). According to the Survey's figures, hard rock constituted about 19 per cent of total Florida production in 1913, about 15 per cent in 1914, and only about 4 per cent in 1915.

The statistics of exports of phosphate rock are compiled by the Bureau of Foreign and Domestic Commerce. The figures for value of the exports represent "value at the time of exportation," and it is assumed that the declared value at the port of shipment includes the cost of freight from mine to seaboard. The addition of freight charges and the larger proportion of high-grade rock included in the exports than in the total output help to explain their greater value per ton.

DOMESTIC PHOSPHATE RESERVES.

Lands remaining in Government ownership that are known or believed to contain valuable phosphate deposits have been temporarily withdrawn from entry. These phosphate reserves are in Florida, Idaho, Utah, Wyoming, and Montana. The work of surveying the western phosphate lands is still going on, and the following

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table shows the extent of the territory covered in the preliminary surveys:

Approximate area of phosphate lands in the United States, in square miles.

Year.	Reconnaissance surveys.	Detail surveys.	Total.
1909	1,000	800	1,800
1910	1,400	500	1,900
1911	1,200	800	2,000
1912	400	400	800
1913	800	1,500	2,300
1914	1,800	470	2,270
1915	1,000	100	1,100
	7,600	4,570	12,170

The classification of phosphate lands under presidential orders has resulted in including 2,660,136 acres of land in the phosphate reserves January 1, 1916.

Phosphate lands withdrawn, restored, and outstanding Jan. 1, 1916, in acres.

State.	Total withdrawals.	Restorations.	Outstanding withdrawals.
Florida	122,816	2,839	119,977
Idaho	2,306,019	1,339,642	966,377
Montana	308,975	178,760	130,215
Utah	805,597	544,846	260,751
Wyoming	3,154,227	1,971,411	1,182,816
	6,697,634	4,037,498	2,660,136

NEW PHOSPHATE ROCK FIELD IN TENNESSEE.

Location.—A new phosphate rock field in Johnson County, in the extreme northeast corner of Tennessee, has been described by Jenkins.[1] This field bears no relation to the middle Tennessee phosphate field.

Field relations.—The phosphate rock of Johnson County occurs usually as a concentration from weathered residual material, which in turn has been formed in the main from dolomitic limestone. Most of it is buff, yellow, or reddish brown, and in places it is in the form of a white and dark-brown breccia, part of which has a laminated texture. Much of the material is so thoroughly weathered that it is very soft, but some of it is hard and has the appearance of chert. At one locality it occurs as a peculiar bluish-black, very hard and tough rock.

Two formations in this field, the Shady limestone and the Watauga shale, of Cambrian age, are more or less phosphatic, especially near the contact between them. In somewhat soluble rocks like these, especially the dolomitic limestone, the soluble material gradually leaches out and the insoluble constituents, like quartz, flint, chert,

[1] Jenkins, O. P., The resources of Tennessee: Tennessee Geol. Survey, vol. 6, No. 2, pp. 51-106, April, 1916.

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chalcedony, and phosphate rock, are left. Solution is facilitated by the numerous cracks and fissures which cut these beds at different angles.

Extent.—The Shady limestone and Watauga shale extend from Butler to Hampton, in Carter County, to Unicoi and Erwin, in Unicoi County, and thence southwest 4 or 5 miles. These formations are also found northeast of Elizabethton, where they extend to Valley Forge and on toward Unicoi, and they occur in the southern part of Greene County and the northern part of Cocke County, south of the Meadow Creek Mountains. The exact extent of these formations is indicated on the maps in certain folios of the Geologic Atlas of the United States.[1] It is not known whether or not phosphatic deposits occur in all the areas covered by these formations, but their extensions must be carefully prospected before the distribution of the phosphate rock will be known and its value proved. It is probable that one or more of the deposits must be actually worked to indicate what may be expected from deposits of this type.

Prospecting for phosphate rock in Johnson County has been done on several hills 2 or 3 miles north of Mountain City, near Cold Spring, and in the region of Maymead, about 4 miles south of Mountain City. Some of the phosphate at both places has the same general appearance, but in the Cold Spring region most of it is soft, earthy, and decomposed, while in places near Maymead it is fairly hard and has a distinct texture. Many small deposits of the material are scattered over the county. The phosphate localities described by Jenkins are in three groups—north of Mountain City, in the Roane Creek valley, and in Doe Valley. The phosphate area of the Roane Creek valley lies principally between Shouns and Neva, in the foothills on the west side of the valley, along the edge of the Doe Mountains. The nearness of these deposits to the railroad makes them especially attractive.

Analyses.—The samples selected by Jenkins and others for complete analysis represented the highest-grade rock of the deposits, but were not the pure phosphate minerals and hence included any gangue minerals present, such as silica, iron ixode, and alumina. The pure phosphate minerals are thought to be collophanite ($Ca_3(PO_4)_2.H_2O$) and dahllite ($2Ca_3(PO_4).CaCO_3.\frac{1}{2}H_2O$) in varying proportions.

Of 22 samples from the region north of Mountain City, the only one that showed more than 60 per cent of calcium phosphate was a surface sample collected by the State geologist, Dr. A. H. Purdue, in May, 1915. The calcium phosphate ranged from 62.34 per cent found in this sample to only a fraction of 1 per cent. Nine samples showed between 50 and 60 per cent, but these percentages are below what the trade demands at present.

Most of the samples collected in the Roane Creek valley and Doe Valley contained less than 50 per cent of calcium phosphate, but a few collected on the places of J. S. Vaught and Charlie Brown, in Roane Creek valley, and some others, showed 60 per cent and more.

The phosphate rock in this region in general is of too low grade to be of present importance, but when commercial conditions change so that low-grade rock will be enriched by chemical treatment or otherwise these deposits may prove of value. The material may also

[1] Cranberry folio (No. 90), Asheville (No. 116), Greeneville (No. 118), and Roan Mountain (No. 151).

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have local value in the form of ground raw rock. However, in the older eastern fields there is an enormous tonnage of phosphate rock, which runs much higher in bone phosphate than the Johnson County material, as judged by the published analyses. Naturally this higher-grade rock will take precedence when chemical methods of conservation are more widely employed or when the rock as mined is more generally ground and spread on the land.

NOTES ON THE CONSERVATION OF PHOSPHATE ROCK.

LOCATION OF DEPOSITS.

The principal phosphate deposits of the United States are in Florida, Tennessee, South Carolina, Kentucky, and Arkansas, in the East, and Montana, Idaho, Wyoming, and Utah, in the West.

PRODUCTION AND EXPORTATION.

Since the mining of phosphate rock began in the United States 50,293,573 long tons has been marketed, and in spite of the abnor-

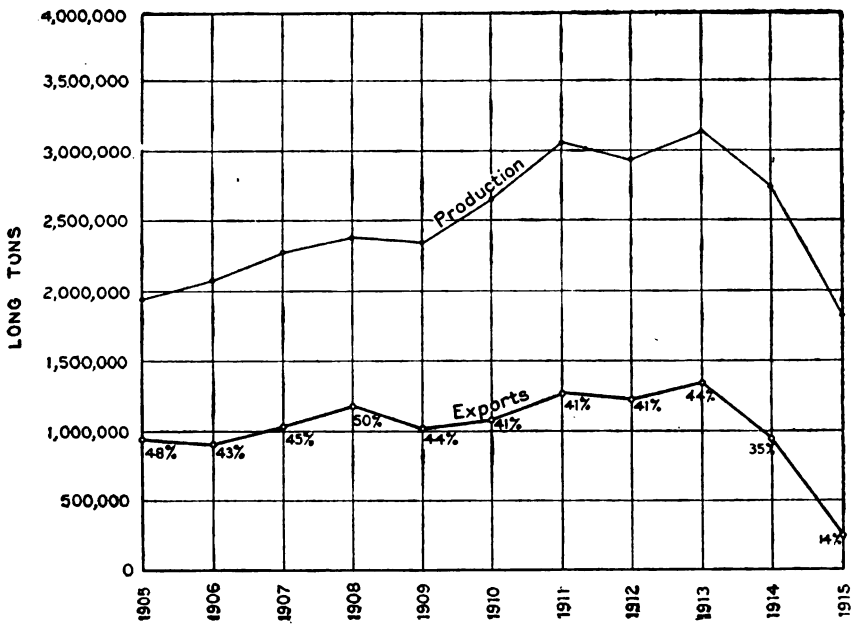

FIGURE 11.—Curve showing production and exports of phosphate rock, 1905–1915. Figures on export curve indicate percentage of production leaving the country.

mally low production during 1914 and 1915, 25,433,232 long tons, or more than half this total, has been produced in the last 10 years. (See fig. 11.) During this 10-year period, again in spite of abnormally low exports in 1914 and 1915, exports have amounted to 10,251,698 tons, or about 40 per cent of the total production in the same period. The exported material does not represent average grades but the highest grade, running 77 per cent and more in calcium phosphate and 3 per cent or less in iron oxide and alumina.

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The bulk of the exports have gone from Florida, for the obvious reason that the Florida deposits are nearest to the seaboard. It is plain that the deposits in this State are being depleted under a system of selecting the cream of the product for export to Europe, leaving the comparatively low-grade rock, running 70 per cent and under in calcium phosphate, for our own fertilizer manufacturers to work up. Realization of this fact should lead American agriculturists and fertilizer manufacturers to demand the highest-grade rock for their own use, both for direct application to the soil and for use in making acid phosphate. It is certainly evident that the European manufacturer is alive to the situation and is buying the highest-grade Pacific island and Florida rock. The disproportionate cost of transporting low-grade rock and the acid phosphate made from it and the evident desirability of keeping our high-grade rock at home are fundamental reasons for a change in policy with reference to our high-grade phosphate.

CONSERVATION OF PHOSPHATE ROCK.

MECHANICAL METHODS.

In the early days of phosphate mining in the more important phosphate fields of the United States there was a large waste of good material. In many places this waste is still going on. In certain localities, particularly in the Tennessee brown-rock field, the material thrown aside is still in such a condition that it may be reworked. In other places it is lost beyond all hope of recovery. The devising of methods to prevent or reduce such loss and yet maintain the grades set by commercial standards is one of the problems now being worked out.

In the Mount Pleasant phosphate field, Tennessee, and to a certain extent in other fields improved methods are being adopted that will result in leaving very little good phosphate rock in the ground. Some phosphate is going into the waste ponds, but without doubt the time will come when all this material will be reworked, and even now some companies are reworking or planning to rework the old tailings. When phosphate rock was first mined in this region probably at least half of the good material, such as is now being worked, was thrown away. A great deal of this can not be recovered, for it has become thoroughly mixed with clay and in places is so deeply covered with overburden that it can not be worked at a profit. The large operators are using up-to-date machinery, but even now some of the small operators are employing the old-fashioned hand methods which have resulted in the loss of much valuable rock.

CHEMICAL METHODS.

Associated with all the large deposits of phosphate rock is considerable rock that is not up to the present commercial requirements in content of calcium phosphate. In the preparation of commercial phosphate rock for the market a great deal of low-grade material is also produced. To bring material of this class up to commercial grade (70 per cent of calcium phosphate) a number of chemical methods have been used. More extended application of these methods will result in the conservation of a great deal of phosphate

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rock now consigned to the waste ponds. Such methods are suggested for use in the western field, owing to the long distances that phosphate rock has now to be transported from this field before it reaches the market. The immense quantities of sulphuric acid potentially available in the immediate vicinity of the western phosphate deposits, which should become available in increasing quantity as time goes on, is another important element in the problem. The chemical method of concentrating phosphates, wherever worked out, will be the means of conserving not only the enormous amount of low-grade rock in the Western States, but a large quantity of low-grade rock in the eastern fields.

SUBSTITUTES FOR PHOSPHATE ROCK.

Substitutes for phosphate rock have been much used, but since the discovery of large deposits of high-grade rock the price of phosphatic fertilizer has greatly decreased, and in consequence the more expensive guanos and other phosphate-bearing materials have been driven out of the market. There is still, however, much phosphatic material of low amd medium grade which could, if necessary, take the place of phosphate rock as a source of phosphorus and which probably will be used at some future time, when commercial conditions change.

The natural substitutes for phosphate rock that have been suggested are phosphatic limestone; phosphatic minerals, like apatite, nelsonite, and wavellite; guano, marl, excrement, and bones; and under the class of artificial substitutes may be included basic slags and manufactured compounds, such as ammonium phosphate.

PHOSPHATE RESERVES IN THE UNITED STATES.

Though the total phosphate reserves in the United States, as indicated below, are very large and will probably last many generations, the supplies of high-grade rock are not inexhaustible.

Estimated quantity of phosphate rock available in the United States.

	Long tons.
Eastern States:	
Florida	227,000,000
Tennessee	88,000,000
South Carolina	9,000,000
Kentucky	1,000,000
Arkansas	20,000,000
	345,000,000
Western States: Montana, Idaho, Utah, and Wyoming	5,367,082,000
	5,712,082,000

The United States is now producing for domestic use and export about 3,000,000 tons of rock annually. More than 99 per cent of this comes from the Eastern States, and in 1915 nearly 75 per cent came from Florida. On this basis the material of good grade in the eastern deposits may last less than 100 years. The western deposits, which are of lower grade, will not be worked out until a far longer time has elapsed.

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AVAILABLE FOREIGN RESERVES.

From recent available data it is evident that the foreign reserves of phosphate are very large, but apparently they are not so large as those within the United States. It must be considered, however, that the North Africa phosphate field, which is thought to extend eastward across Arabia into Persia, has not been explored sufficiently to show even approximately its real magnitude. The Algerian deposits are apparently of low grade, but their quantity runs up into hundreds of millions of tons. The deposits of high-grade rock of the South Sea Islands, which naturally will be worked first, are estimated to contain 70,000,000 tons.

PROCESSES FOR MAKING SOLUBLE PHOSPHATES.

W. S. Landis [1] has devised a process of rendering soluble the phosphate contained in ordinary phosphate rock, and claims that it is more expeditious and efficient than methods heretofore proposed. The phosphate rock and sodium sulphate or carbonate that are used to bring about the reaction are reduced to a fine powder and treated with water. Finely divided carbon, such as coal or coke, is mixed with the wet mass, or the mixture may be ground wet after the addition of the carbon. The mixture is placed on a suitable perforated grate and ignited, while air is forced through under pressure to make certain that clinkering and burning take place simultaneously with the drying. If the sodium salt separates, the efficiency of the conversion of the insoluble to the soluble phosphate is greatly lessened, but clinkering and burning follow so quickly after drying that there is no time for crystals of sodium salts to form. The mass dries very quickly, puffs up, and sinsters in a very satisfactory manner, and the analysis show a high yield of soluble phosphate. After the reaction takes place the material is finely ground to make it of the highest availability.

J. W. Beckman [2] has invented a process that provides a simple and comparatively inexpensive method of producing fertilizer containing potash and phosphoric acid in readily available concentrated form and in chemical combination. One specific method of carrying out the process is as follows: Alunite (K_2O, $3Al_2O_3$, $4SO_3.6H_2O$) and rock phosphate ($Ca_3(PO_4)_2$) are mixed in suitable proportions, which need not be limited to the chemical equivalents. The mixture is then heated in a furnace to or above a red heat, and in the reaction which ensues potassium phosphate is produced. This may be dissolved in water and purified. The reaction is said to be assisted by the presence of seemingly inert substances, the exact function of which is not thoroughly understood. Silica is taken as an example of these substances.

A. H. Cowles [3] has devised a process for rendering available the phosphoric acid in phosphate rock, in which potash-aluminum silicate is used as the opening reagent at high temperature. Cowles has found that by taking bone ash, apatite, or phosphate rock and adding sufficient feldspar to furnish one molecular weight of silica to each

[1] United States patent 1103050, July 14, 1914.
[2] United States patent 1121160, Dec. 15, 1914.
[3] United States patent 1126406, Jan. 26, 1915.

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two molecular weights of lime, or its equivalent, a mixture is obtained which after being heated to or above the sintering point yields on treatment with acid all the phosphoric acid contained in the original phosphate rock and also the potassium and aluminum in feldspar. Due allowance must be made for chemical equivalents of other compounds containing the same bases, or other bases replacing those in the theoretical formula of the feldspar, for example. If the product is treated with sulphuric acid in just sufficient quantity to dissolve the alumina and potash in it, these bases will form soluble sulphates or the double sulphate potash alum and the phosphoric acid will be set free. Hydrochloric acid may be employed instead of sulphuric. The process may be carried out in furnaces of different forms, but preferably in a rotary furnace similar to that used in cement burning. The temperature required ranges from 1,000°, to 1,700° C. After sintering or fusion, followed by disintegration, the product as it comes from the furnace is ground and may be used directly as a fertilizer. By treatment with acid or solutions of salts that will not cause insoluble phosphates or aluminates to form, it may be leached and the phosphoric acid and other valuable salts then separated by any well-known chemical method.

S. Peacock[1] has devised a process of separating phosphorus from its combinations in phosphates and producing at the same time carbides and nitrides of phosphorus which may be used in the production of phosphorus oxides or nitrogen salts. Finely divided phosphate rock is mixed with a suitable quantity of finely divided carbon, such as ground coke, coal dust, or other form of fuel carbon. The mixture is then heated to a temperature of about 900° C. in an atmosphere containing no free oxygen. Under such conditions the phosphorus is evolved either in the form of a vapor or as a carbide, such as P_2C_5. If the reaction is carried out in an atmosphere of nitrogen, phosphorus is given off as a nitride, such as P_3N_5, or as a carbo-nitride, such as $P_2C_5N_{10}$, or as a mixture of these two substances together with some carbide and free phosphorus. The rapidity of the reaction is increased by raising the temperature to 1,100°–1,300° C., and decomposition is facilitated by maintaining a low partial pressure of the reaction products. The gaseous phosphorus compounds may then be wholly decomposed by passing them through fire-clay tubes maintained at temperatures of 1,200° to 1,400° C., and the free phosphorus can be recovered in the ususal manner by condensation. Or the gaseous compound may be burned in air to produce the phosphorus pentoxide (P_2O_5) ,which may be recovered as such or combined with water to form phosphoric acid (H_3PO_4). If phosphorus nitride (P_3N_5) is present in sufficient quantity to render the recovery of the nitrogen profitable, this gas may be pumped into an autoclave and treated with superheated steam at a pressure of not less than two atmospheres, when the following reaction takes place:

$$P_3N_5 + 24H_2O = 6NH_4.H_2PO_4 + 4NH_3.$$

Other reactions are given for other gases—for example, phosphorus carbonitride ($P_2C_5N_{10}$) and phosphorus carbide (P_2C_5), when subjected to the action of steam.

[1] United States patent 1129504, Feb. 23, 1915.

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W. S. Landis[1] describes an improvement in rendering phosphoric acid available, making use of specific reagents, as follows: Phosphate rock and sodium sulphate are ground together as finely as possible. A dry tube mill is satisfactory which grinds, say, from 85 to 90 per cent of the material so that it will pass through a 200-mesh screen. The mixture should contain 20 parts of dry sodium sulphate or its equivalent in niter cake for every 100 parts of phosphate rock running less than 10 per cent silica. To this mixture, either in the grinding mill or in any separate device, is added 15 parts of bituminous coal, preferably a gas coal containing from 60 to 70 per cent of carbon. This mixture may be made in a grinding mill and the whole mass of rock, soda, and coal ground to pass a screen of the desired mesh at one operation. The dry mixture is then fed into a rotary cement kiln, where a full white heat should be maintained in the combustion zone with an oxidizing atmosphere as far as possible throughout the rest of the kiln. The mixture is charged into the upper end of the kiln—

and as it heats up the coal ignites and reduces the sodium sulphate added to sodium sulphide. As this reduced material passes down through the kiln the sulphide readily oxidizes and nearly all of its sulphur content leaves the kiln in the form of sulphur dioxide. If the kiln is sufficiently long, and the feed properly proportioned, it is found that by the time this mixture reaches the burning zone there is only a trace of sulphur left in the mixture. In the burning zone the sodium begins to react with the constituents of the rock, and as the temperature should be carried at a white heat or above, a sintering or clinkering takes place, just as in the cement kiln, and a brownish product is discharged from the kiln, which, if finely ground, shows upward of 90 per cent of the total P_2O_5 present in a citrate-soluble form.

It is important to the success of the process that the temperature of the kiln be kept at such point that an incipient fusion actually does take place, or the kiln charge will not be transformed into an available phosphate form. The mere passage of the material through the kiln without this clinkering is not sufficient to render the P_2O_5 available. * * * The average of a long series of runs made according to the above process yielded from a Folrida rock containing 30.6 per cent P_2O_5 a finished product containing total P_2O_5, 29.8 per cent; available P_2O_5, 26.7 per cent; insoluble P_2O_5, 3.1 per cent.

On crowding the kiln to the very limit of capacity and at the same time leaving sufficient space for the passage of the gases without actually carrying the larger part of the charge out of the kiln, there was obtained a product containing total P_2O_5, 29.9 per cent; available P_2O_5, 25.1 per cent; insoluble P_2O_5, 4.8 per cent. These results show that excessive overfeeding of the kiln does not have an extremely serious effect upon the availability of the finished product. In case, however, the temperature of the kiln drops below the point necessary for clinkering, the availability drops off very considerably, as shown by the following example, in which the temperature in the burning zone was only 1,200° C.: Total P_2O_5, 29.3 per cent; available P_2O_5, 14.4 per cent; insoluble P_2O_5, 14 per cent. It is, therefore, extremely important that one maintain temperatures of upward of 1,400° C. in the combustion zone of the kiln.

Robert Stewart[2] has devised a process of producing acid monocalcium phosphate, as follows: Phosphate rock is heated with smelter smoke in the presence of steam or water vapor whereby acid monocalcium phosphate and acid calcium sulphite are produced, as indicated in the following reaction:

$$Ca_3(PO_4)_2+4SO_2+4H_2O=CaH_4(PO_4)_2+2Ca(HSO_3)_2$$

When the solution containing acid monocalcium phosphate and the acid calcium sulphite is concentrated, the sulphite decomposes, normal

[1] United States patent 1137065, Apr. 27, 1915.
[2] United States patent 1137806, May 4, 1915.

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calcium sulphite is formed, and sulphur dioxide is liberated, as shown in the following equation:

$$2Ca(HSO_3)_2 = 2CaSO_3 + 2SO_2 + 2H_2O.$$

The acid monocalcium phosphate decomposes part of the calcium sulphite, producing dicalcium phosphate, as follows:

$$CaH_4(PO_4)_2 + CaSO_3 = Ca_2H_2(PO_4)_2 + SO_2 + H_2O.$$

As the dicalcium phosphate is said to be of less agricultural value than the acid monocalcium phosphate, and as from the above reactions the monocalcium phosphate can not be removed as such without removing the acid calcium sulphite produced in the first reaction, the sulphite must be removed or changed, and this is accomplished by oxidation, whereby the following reaction occurs:

$$Ca(HSO_3)_2 + 2O = CaSO_4 + H_2SO_4.$$

The solution may then be concentrated by evaporation, without decomposition of the acid monocalcium phosphate.

F. S. Washburn [1] has devised a process for making ammonium phosphate. Only an outline of the method is given below, and for details of construction and manipulation the reader should consult the original patent specifications. Washburn starts with phosphate rock and adds sufficient sulphuric acid to convert it to calcium sulphate, to free the phosphoric acid, and to dissolve the impurities in the rock. The solution of phosphoric acid is next separated from the calcium sulphate by filtration and washing, whereby crude phosphoric acid is formed, which contains only a few tenths of 1 per cent of such impurities as iron, alumina, and soluble lime, with a small quantity of free sulphuric acid. This solution is then ammoniated either by adding aqua ammonia or passing through it the ammonia vapor produced from calcium cyanamid or lime nitrogen. The product formed on evaporation is tapped off into a rather high vacuum chamber. The mass then puffs up, becomes very porous, and is easily granulated or crushed for admixture with fertilizers.

T. L. Wilson and M. M. Haff [2] have devised an improved process for ammoniating acid phosphate to prevent reversion of the compound to the insoluble form after the ammonia has been added. This end is accomplished by artificially drying the acid phosphate before adding the ammonia until the moisture in the mixture is reduced from 13 to 6 per cent. Ammonia is next introduced in the form of gas.

SIMPLE TESTS FOR PHOSPHATES.

By W. B. Hicks.

The simple tests for phosphates described below are well known and have been in general use for many years. They are described here for the benefit of those who may not have access to textbooks on the subject. As phosphate rock is the commercial source of phosphates, only methods directly applicable to the detection of phosphates in such rock are given.

[1] United States patent 1151074, Aug. 24, 1915. [2] United States patent 1127840, Feb. 9, 1915.

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For field use probably the simplest and most satisfactory method of detecting phosphates in phosphate rock is to moisten the fresh rock surface with a drop of nitric acid (specific gravity 1.2) and then to place a small crystal of ammonium molybdate on the moist spot. In the presence of appreciable amounts of phosphates a yellow color, due to the formation of ammonium phosphomolybdate, will gradually spread through the crystal and over the rock surface. This test is rather sensitive and will reveal phosphates in much smaller than commercial quantities.

When the proper equipment is at hand, however, the test may be carried out more satisfactorily and made even more delicate by placing a very small quantity of the powdered rock in a test tube, adding a few drops of nitric acid (specific gravity 1.2), warming gently over the flame, diluting with a little water, and adding an excess of ammonium molybdate solution. In the presence of even very small quantities of phosphates a yellow precipitate of ammonium phosphomolybdate will form on standing in the cold and more quickly on heating.

A rough estimate of the quantity of phosphate in the rock may be made by comparing the yellow precipitate with that produced by rock samples of known composition under similar treatment. The comparison should be made with rock samples known to contain 5, 10, 15, 20, 30, and 40 per cent of phosphoric acid (P_2O_5). Exactly the same quantity of powdered rock should be taken, the same amount of reagents should be added, and the volume of the solution should be kept constant. In other words, uniform conditions must be maintained throughout the tests.

The ammonium molybdate solution for the tests is prepared by dissolving 75 grams of ammonium molybdate in 500 cubic centimeters of water and slowly pouring this solution into 500 cubic centimeters of nitric acid (specific gravity 1.2), with constant stirring. White molybdic oxide will form at first and will then redissolve. After standing and being filtered the solution is ready for use.

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LIME.

By G. F. Loughlin.

LIME SOLD IN 1915.

The lime manufactured and sold in the United States in 1915 amounted to 3,589,699 short tons, valued at $14,336,756. This was an increase of 208,771 tons, or 6 per cent, in quantity and of $1,067,818, or about 8 per cent, in value compared with sales in 1914. It nearly equaled the record output of 1913, as shown in the following table:

Lime burned and sold in the United States, 1906–1915.

	Quantity (short tons).	Value.[a]	Average price per ton.	Number of plants in operation.
1906	3,198,087	$12,480,653	$3.90	979
1907	3,092,524	12,656,705	4.09	899
1908	2,766,373	11,091,186	4.01	949
1909	3,484,974	13,846,072	3.98	1,232
1910	3,505,954	14,088,039	4.02	1,125
1911	3,392,915	13,689,054	4.03	1,139
1912	3,529,462	13,970,114	3.96	1,017
1913	3,595,390	14,648,362	4.07	1,023
1914	3,380,928	13,268,938	3.92	954
1915	3,589,699	14,336,756	3.99	905

[a] The value given represents the value of bulk lime f. o. b. at point of shipment and does not include weight or cost of barrel or package.

In 1915 sales of lime were reported from 43 States, 1 more than in 1914 and 1 less than in 1913. One plant in Wyoming, idle in 1914, resumed operations in 1915. Of the 9 leading States, 7 showed increase and 2, Wisconsin and Missouri, showed decrease in both quantity and value. Approximately the same ratio of increase to decrease holds for the first 20 States, but in the remaining States there was a prevailing decrease in both quantity and value, as shown in the accompanying table of production by States.

The five leading States in 1915 were, according to quantity of lime sold, Pennsylvania, Ohio, Virginia, West Virginia, and Wisconsin; according to value, Maine ranked third and Wisconsin sixth. In 1914 the order according to quantity was Pennsylvania, Ohio, Virginia, Wisconsin, and West Virginia. Wisconsin, which fell from third to fourth place in 1914, dropped to fifth place in 1915.

The lime sold in Pennsylvania amounted to 25 per cent of the total quantity and 20 per cent of the total value; that sold in Ohio to 14 per cent of both total quantity and total value. That from Ohio, however, was produced from 41 plants, whereas that of Pennsylvania came from 451 operations, mostly the stack kilns of farmers who burn lime in small quantities for their own or their neighbors' farms.

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Lime burned and sold in the United States in 1914 and 1915.

1914.

State or Territory.	Rank of State by quantity.	Quantity (short tons).	Value.	Rank of State by value.	Average price per ton.	Number of plants in operation.
Alabama	17	46,966	$199,814	18	$4.25	12
Arizona	23	19,093	122,324	21	6.41	3
Arkansas	22	19,230	92,067	23	4.79	6
California	16	55,492	430,792	9	7.76	16
Colorado	32	5,415	38,996	29	6.83	4
Connecticut	14	70,534	338,601	14	4.80	10
Florida	26	12,376	64,531	25	5.21	5
Georgia	42	(a)	(a)	42	3.50	1
Hawaii	34	(a)	(a)	27	10.00	1
Idaho	33	(a)	(a)	34	5.00	2
Illinois	12	87,603	383,989	12	4.38	16
Indiana	10	99,185	358,738	13	3.62	9
Iowa	25	(a)	(a)	26	4.52	2
Kentucky	29	5,978	26,762	33	4.47	9
Maine	8	122,218	512,842	8	4.20	5
Maryland	9	115,845	390,298	11	3.37	4
Massachusetts	7	124,199	652,067	7	5.25	11
Michigan	15	66,507	287,648	15	4.33	10
Minnesota	21	22,057	104,195	22	4.72	5
Missouri	6	155,680	686,051	5	4.41	24
Montana	31	(a)	(a)	32	5.86	2
Nevada	37	(a)	(a)	36	6.50	1
New Jersey	27	10,953	41,226	28	3.76	10
New Mexico	41	(a)	(a)	40	7.00	2
New York	11	94,009	396,494	10	4.22	26
North Carolina	28	8,098	36,356	31	4.49	3
Ohio	2	480,010	1,880,836	2	3.92	44
Oklahoma	39	2,293	11,130	39	4.77	4
Oregon	36	3,143	21,576	35	6.86	4
Pennsylvania	1	849,963	2,740,238	1	3.22	476
Porto Rico	35	4,231	15,835	38	3.74	36
Rhode Island	38	(a)	(a)	37	7.00	1
South Carolina	40	(a)	(a)	41	2.93	1
South Dakota	30	5,603	36,976	30	6.60	4
Tennessee	13	85,939	266,881	16	3.11	14
Texas	18	37,365	200,788	17	5.37	10
Utah	24	12,425	74,212	24	5.97	11
Vermont	20	28,758	142,034	20	4.94	8
Virginia	3	243,990	763,775	4	3.13	40
Washington	19	29,430	189,260	19	6.43	8
West Virginia	5	192,195	680,065	6	3.54	28
Wisconsin	4	227,469	871,820	3	3.83	36
Other States	.....	36,676	211,721	.....	.....	.....
	.....	3,380,928	13,268,938	.....	3.92	954

a Included in "Other States."

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Lime burned and sold in the United States in 1914 and 1915—Continued.

1915.

State or Territory.	Rank of State by quantity.	Quantity (short tons).	Value.	Rank of State by value.	Average price per ton.	Number of plants in operation.
Alabama	16	60,332	$250,227	17	$4.15	14
Arizona	24	14,137	90,931	22	6.43	3
Arkansas	22	15,879	78,112	24	4.92	6
California	17	57,292	431,424	10	7.53	18
Colorado	32	4,647	29,131	32	6.27	5
Connecticut	15	76,022	368,343	13	4.85	6
Florida	23	15,306	78,240	23	5.11	4
Georgia	42	(a)	(a)	43	2.50	1
Hawaii	29	(a)	(a)	26	9.32	1
Idaho	35	3,357	19,247	35	5.73	4
Illinois	12	88,604	352,954	14	3.98	14
Indiana	11	99,916	374,221	12	3.74	8
Iowa	27	(a)	(a)	27	5.12	2
Kentucky	39	1,307	7,070	39	5.41	9
Maine	6	146,400	945,108	3	6.46	4
Maryland	10	111,023	409,588	11	3.69	34
Massachusetts	8	135,580	669,629	7	4.94	10
Michigan	14	81,359	349,979	15	4.31	10
Minnesota	21	20,359	96,190	21	4.72	5
Missouri	7	135,901	573,442	9	4.22	21
Montana	33	(a)	(a)	34	6.00	2
Nevada	28	(a)	(a)	28	6.50	1
New Jersey	26	10,273	35,393	29	3.45	10
New Mexico	38	1,720	11,963	38	6.96	4
New York	9	115,861	575,384	8	4.97	25
North Carolina	30	(a)	(a)	33	4.92	2
Ohio	2	507,993	1,964,810	2	3.85	41
Oklahoma	40	(a)	(a)	40	7.72	2
Oregon	34	4,188	30,411	31	7.26	4
Pennsylvania	1	901,549	2,947,058	1	3.27	451
Porto Rico	36	3,118	16,983	37	5.45	23
Rhode Island	37	(a)	(a)	36	7.00	1
South Carolina	41	(a)	(a)	41	3.33	1
South Dakota	31	5,625	34,728	30	6.17	3
Tennessee	13	82,765	256,069	16	3.09	14
Texas	18	39,468	211,516	18	5.36	10
Utah	25	11,460	67,273	25	5.87	10
Vermont	19	37,992	187,144	19	4.93	8
Virginia	3	267,278	840,969	5	3.15	40
Washington	20	27,240	171,023	20	6.28	8
West Virginia	4	250,000	896,520	4	3.59	30
Wisconsin	5	221,147	755,986	6	3.42	35
Wyoming	43	(a)	(a)	42	12.50	1
Other States	.....	34,601	219,690	.....	.....	.....
	.....	3,589,699	14,336,756	.....	3.99	905

a Included in "Other States."

This practice of burning in small quantities has been declining for several years on account of the difficulty in obtaining labor and also because of the scarcity of wood for burning and of the increased cost of coal. The value of lime burned for use by farmers continues to range from 6 to 12 cents a bushel of 70 to 80 pounds (equivalent to $1.60 to $3.20 a short ton), according to whether the fuel is purchased or obtained on the farm. The average price of this lime has increased slightly in recent years, but is still so low as to decrease considerably the total value and average price per ton for the State. The use of coal instead of wood for fuel is increasing, especially where the farmers can obtain the coal on their own farms.

A considerable quantity of lime is also burned in small quantities for agricultural use in Maryland, Virginia, and West Virginia. A quantity of marl burned or dried and used for agricultural purposes

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is included in the lime figures for New York, North Carolina, South Carolina, and Wisconsin.

In addition to the lime burned by the producers a quantity of limestone is sold each year by producers to various burners of lime in small kilns; furthermore, limestone quarried in Ohio is shipped in considerable quantity to Wisconsin and Minnesota to be burned into lime. The quantity of limestone thus sold in 1915 was 115,088 short tons, valued at $75,656, equivalent to about 60,000 tons of burned lime. As these sales are of limestone produced and sold as stone, their quantity and value are tabulated in the stone report.

A considerable quantity of limestone sold by quarrymen to sugar refineries, smelteries, and alkali works and burned at these plants is also tabulated in the stone report, but the figures are repeated here in the section on "Uses."

The average price per ton increased in 1915 and was about midway between the average prices of 1913 and 1914. The increase, however, was not general, as the average price was affected by local variations in demand for different kinds of lime. With respect to the uses of lime, there was a tendency for the leading States producing large quantities of lime for chemical works, sugar factories, fertilizer, and "other purposes" to show increase in average price, whereas those States producing mostly lime for building, paper mills, tanneries, and dealers showed decrease. Of the first 20 States, 16 conformed to this rule, but the rule did not apply to the States of lower rank. As a whole the States with increase and those with decrease in average price were equally divided, and as in previous years the rate of increase and decrease varied greatly from State to State. The Atlantic States for the most part were marked by increase in average price in 1915, which offset the decrease in 1914. In Maryland, West Virginia, Kentucky, and Indiana the average price continued to increase, whereas in New Jersey, Ohio, Georgia, and Florida, it continued to decrease. Among the Mississippi Valley States where the average price decreased in 1914, it continued to decrease in Wisconsin, Illinois, and Missouri, whereas it remained stationary in Minnesota and increased in Iowa and Arkansas. There was a prevailing decrease in average price in 1915 in the western and southwestern interior States, but the decrease in 1915 did not equal the gain in 1914. Utah was the only State to show a material decrease in average price for both years. There was a prevailing increase in the Northwest, except in Washington. Oregon showed substantial increase in both 1914 and 1915. In California the average price, which increased slightly in 1914, decreased considerably in 1915. The largest increase in average price in 1915 was in Oklahoma ($2.95), Maine ($2.26), and Kentucky (94 cents); the largest decrease was in Colorado (56 cents) and Georgia ($1). In each of these States the extent of the industry is too small for the changes in average price to be of much significance to the lime industry as a whole.

Further discussion of prices and industrial conditions is given in the section on "Uses."

The number of plants, 905, operating in 1915 was, with the exception of 1907, the smallest since record of them was first made in 1906. The decrease was evidently in part temporary, owing to continuation

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of unfavorable conditions, especially in the building trades, but in part it marked a further tendency of the industry toward combination and the cessation of small operations because of the increasing cost of production. The number of kilns in operation also decreased from 2,406 in 1914 to 2,333 in 1915.

UNITS OF MEASUREMENT.

The expression of quantity in tons in the foregoing tables is a recalculation of the quantities by weight reported by producers. At present there is no standard unit of quantity. Some producers report quantity in bushels, which vary in weight from 40 to 80 pounds. The number of pounds in a bushel depends upon the State in which the lime is sold, and some producers within a single State report various weights per bushel. The weight of a barrel of lime ranges from 160 to 300 pounds and may or may not include the weight of the barrel.

Opposition among lime producers, especially the National Lime Manufacturers' Association, to the bill (H. R. 4899, 1st sess. 63d Cong.) fixing the dimensions of the standard barrel for dry commodities recently caused the passage of the following act (S. 5425, 1st sess. 64th Cong.):

AN ACT To standardize lime barrels.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby established a large and a small barrel of lime, the large barrel to consist of two hundred and eighty pounds and the small barrel to consist of one hundred and eighty pounds, net weight.

SEC. 2. That it shall be unlawful for any person to sell or offer for sale lime imported in barrels from a foreign country, or to sell or offer for sale lime in barrels for shipment from any State or Territory or the District of Columbia, to any other State or Territory or the District of Columbia, unless there shall be stencilled or otherwise clearly marked on one or both heads of the small barrel the figures "180 lbs. net" and of the large barrel the figures "280 lbs. net" before the importation or shipment, and on either barrel in addition the name of the manufacturer of the lime and where manufactured, and, if imported, the name of the country from which it is imported.

SEC. 3. When lime is sold in interstate or foreign commerce in containers of less capacity than the standard small barrel, it shall be sold in fractional parts of said standard small barrel, and the net weight of lime contained in such container shall by stencil or otherwise be clearly marked thereon, together with the name of the manufacturer thereof, and the name of the brand, if any, under which it is sold, and, if imported, the name of the country from which it is imported.

SEC. 4. That rules and regulations for the enforcement of this Act, not inconsistent with the provisions of the Act, shall be made by the Director of the Bureau of Standards and approved by the Secretary of Commerce, and that such rules and regulations shall include reasonable variations or tolerances which may be allowed.

SEC. 5. That it shall be unlawful to pack, sell, or offer for sale for shipment from any State or Territory or the District of Columbia to any other State or Territory or the District of Columbia, any barrels or other containers of lime which are not marked as provided in sections two and three of this Act, or to sell, charge for, or purport to deliver from any State or Territory or the District of Columbia to any other State or Territory or the District of Columbia, as a large or small barrel or a fractional part of said small barrel of lime, any less weight of lime than is established by the provisions of this Act; and any person guilty of a violation of the provisions of this Act shall be deemed guilty of a misdemeanor and be liable to a fine not exceeding $100.

SEC. 6. That it shall be the duty of each district attorney, to whom satisfactory evidence of any violation of this Act is presented, to cause appropriate proceedings to be commenced and prosecuted in the United States court having jurisdiction of such offense: *Provided, however,* That the penal provisions of this Act shall not take effect until January first, nineteen hundred and seventeen.

SEC. 7. That this Act shall be in force and effect from and after its passage.

Approved, August 23, 1916.

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USES.

Lime is used for a great variety of purposes, which have been given in detail in previous reports on this subject. The principal uses, as far as it is possible to give them, are shown in the following table. Under the head of "Dealers—uses not specified" is included a considerable quantity of lime, which, distributed, would necessarily raise the figures for all the other uses, especially for building, but the manufacturers were not able to classify the figures given under this heading.

The first of the following tables shows the total quantity and value of lime sold for different uses in 1914 and 1915. The second table gives for the first time the quantity and value of lime sold in the different States according to uses.

Lime sold in the United States in 1914 and 1915, by uses.

1914.

	Quantity (short tons).	Value.	Average price per ton.
Building lime	1,163,433	$5,068,375	$4.36
Chemical works	367,497	1,202,178	3.27
Paper mills	242,998	915,369	3.77
Sugar factories	31,931	187,605	5.88
Tanneries	49,393	212,653	4.31
Fertilizer	684,348	2,139,444	3.13
Dealers—uses not specified	646,490	2,791,139	4.32
Other uses [a]	194,838	752,175	3.86
	3,380,928	13,268,938	3.92
Hydrated lime, included in total	515,121	2,239,916	4.35

1915.

Building lime	1,136,696	$4,812,710	$4.23
Chemical works	492,870	1,653,750	3.36
Paper mills	216,819	782,396	3.61
Sugar factories	34,025	230,368	6.77
Tanneries	47,104	190,864	4.06
Fertilizer	653,686	2,163,874	3.31
Dealers—uses not specified	595,128	2,508,907	4.22
Other uses [a]	413,371	1,993,887	4.82
	3,589,699	14,336,756	3.99
Percentage of increase in 1915	6.2	8.0	.....
Hydrated lime, included in total	581,114	2,457,602	4.23
Percentage of increase in 1915	12.8	9.7	.....

[a] Includes lime for sand-lime brick, slag cement, alkali works, steelworks, glassworks, smelters, sheep dipping, disinfectant, manufacture of soap, cyanide plants, glue factories, purification of water, etc.

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The second table gives a good idea of the extent of the lime industry in different groups of States. Nine States east of the Mississippi River, as well as Missouri and California, supply lime for all uses listed in the table, and to these may be added New York and Wisconsin, in which only one or two of these uses are not represented. These 13 States range from 1 to 19 in rank of total production; 9 of them showed increase in both quantity and value of lime sold in 1915, as compared with 1914; Illinois showed a slight increase in quantity but a marked decrease in value; and Missouri, Tennessee, and Wisconsin showed decrease in both quantity and value.

Lime sold in the United States in 1915, by States and uses.

State.	Building.		Chemical works.		Paper mills.		Sugar factories.		Tanneries.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	13,187	$54,976	1,369	$5,769	(a)	(a)	801	$3,358	(a)	(a)
Arizona	(a)	(a)								
Arkansas	12,526	60,849								
California	12,155	82,252	(a)	(a)	(a)	(a)	16,243	151,945	(a)	(a)
Colorado	1,411	6,946	(a)	(a)			(a)	(a)		
Connecticut	74,956	363,676								
Florida	15,306	78,240								
Georgia	(a)	(a)								
Idaho	(a)	(a)	(a)	(a)						
Illinois	40,072	178,716	8,642	32,131	5,991	$24,284	(a)	(a)	(a)	(a)
Indiana	18,649	78,406	10,782	43,034	16,683	57,779	(a)	(a)	5,038	$17,676
Iowa	(a)	(a)								
Kentucky	464	2,735								
Maine	(a)	(a)								
Maryland	7,516	25,225	9,455	26,395						
Massachusetts	81,951	482,015	(a)	(a)	(a)	(a)				
Michigan	1,839	7,168	48,211	212,051	6,043	23,133	610	2,315	4,092	20,100
Minnesota	20,359	96,190								
Missouri	32,045	146,598	20,192	80,976	2,750	11,000	880	3,520	784	3,044
Montana	(a)	(a)								
New Jersey	(a)	(a)								
New Mexico	645	4,706								
New York	2,681	12,742	29,100	142,228	20,020	88,574			1,935	17,313
North Carolina					(a)	(a)				
Ohio	182,164	716,591	9,197	32,101	14,155	46,214	(a)	(a)	(a)	(a)
Oklahoma	(a)	(a)								
Oregon	(a)	(a)								
Pennsylvania	284,239	1,049,135	107,407	344,201	50,657	165,135	1,190	3,689	11,804	38,373
Porto Rico	1,260	5,382					952	7,895		
Rhode Island									(a)	(a)
South Dakota	(a)	(a)	(a)	(a)						
Tennessee	30,689	98,010	(a)	(a)	21,090	59,678	7,790	29,970	786	2,343
Texas	11,713	64,290			(a)	(a)	(a)	(a)	(a)	(a)
Utah	5,100	36,942	(a)	(a)			(a)	(a)		
Vermont	6,420	33,110	12,246	60,745	6,707	31,904	(a)	(a)	8,432	41,560
Virginia	67,050	284,617	122,883	274,208	7,309	29,266	(a)	(a)	5,964	16,055
Washington	17,453	110,216	(a)	(a)	(a)	(a)	(a)	(a)		
West Virginia	(a)	(a)	88,916	298,235						
Wisconsin	123,604	422,097			16,997	59,910			1,351	5,514
Wyoming	(a)	(a)								
Other States	71,252	310,880	24,470	101,676	48,417	185,519	5,559	27,666	6,918	28,886
	1,136,696	4,812,710	492,870	1,653,750	216,819	782,396	34,025	230,368	47,104	190,864

a Included in "Other States."

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Lime sold in the United States in 1915, by States and uses—Continued.

State.	Fertilizer.		Dealers.		Other uses.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	379	$1,308	40,031	$169,600	1,303	$5,163	60,332	$250,227
Arizona			(a)	(a)			14,137	90,931
Arkansas			(a)	(a)	(a)	(a)	15,879	78,112
California	6,219	28,606	15,449	118,127	5,442	37,236	57,292	431,424
Colorado	(a)	(a)	(a)	(a)	(a)	(a)	4,647	29,131
Connecticut	1,066	4,667					76,022	368,343
Florida							15,306	78,240
Georgia	(a)	(a)					(a)	(a)
Hawaii	(a)	(a)			(a)	(a)	(a)	(a)
Idaho			(a)	(a)			3,357	19,247
Illinois	(a)	(a)	20,884	75,764	6,787	17,189	88,604	352,954
Indiana	6,207	20,065	28,347	108,961	14,090	47,864	99,916	374,221
Iowa			(a)	(a)			(a)	(a)
Kentucky	188	525	(a)	(a)	(a)	(a)	1,307	7,070
Maine	(a)	(a)			(a)	(a)	146,400	945,108
Maryland	93,602	356,768	450	1,200			111,023	409,588
Massachusetts	4,257	11,325					135,580	669,629
Michigan	(a)	(a)	8,989	39,506	11,075	43,706	81,359	349,979
Minnesota							20,359	96,190
Missouri	676	2,467	57,496	244,968	21,078	80,869	135,901	573,442
Montana					(a)	(a)	(a)	(a)
Nevada					(a)	(a)	(a)	(a)
New Jersey	8,909	27,610	299	1,561			10,273	35,393
New Mexico					(a)	(a)	1,720	11,963
New York	26,824	81,468	14,182	70,385	21,119	162,674	115,861	575,384
North Carolina	(a)	(a)	(a)	(a)			(a)	(a)
Ohio	54,118	203,221	192,044	767,527	55,898	187,841	507,993	1,954,810
Oklahoma			(a)	(a)			(a)	(a)
Oregon			(a)	(a)			4,188	30,411
Pennsylvania	345,960	995,703	55,839	215,053	44,453	135,769	901,549	2,947,058
Porto Rico	722	2,876			184	830	3,118	16,983
Rhode Island	(a)	(a)	(a)	(a)			(a)	(a)
South Carolina	(a)	(a)					(a)	(a)
South Dakota					(a)	(a)	5,625	34,728
Tennessee	3,520	9,150	4,836	14,730	7,804	23,438	82,765	256,089
Texas	(a)	(a)	23,629	126,572	1,980	10,216	39,468	211,516
Utah			(a)	(a)	(a)	(a)	11,460	67,273
Vermont	(a)	(a)	3,606	17,030	(a)	(a)	37,992	187,144
Virginia	45,149	170,557	(a)	(a)	(a)	(a)	267,278	840,969
Washington	(a)	(a)	(a)	(a)	(a)	(a)	27,240	171,023
West Virginia	32,558	111,921	10,037	23,955	78,932	317,065	250,000	896,520
Wisconsin	378	606	71,878	240,007	6,939	27,852	221,147	755,966
Wyoming							(a)	(a)
Other States	22,954	135,031	47,132	273,961	136,287	896,175	b 34,601	b 219,690
	653,686	2,163,874	595,128	2,508,907	413,371	1,993,887	3,589,699	14,336,756

a Included in "Other States."
b Includes Georgia, Hawaii, Iowa, Montana, Nevada, North Carolina, Oklahoma, Rhode Island, South Carolina, and Wyoming.

Building.—Lime used for building represents about one-third of the total lime sold—probably one-half if this product were segregated from the quantity sold to dealers. Building lime in 1915 decreased both in quantity (2 per cent) and in value (5 per cent), as compared with the sales in 1914. The average price per ton which decreased 9 cents in 1914 decreased 13 cents more in 1915. There has been a general decrease in quantity and value in the last six years, during which time the average price per ton has fluctuated from $4.22 (in 1912) to $4.54 (in 1911).

In 38 of the 43 lime-producing States, lime was sold for building, and in 2 of the remaining 5 States lime sold to dealers was probably used in large part for building. Pennsylvania was the leading State, with total lime sold directly for building valued at more than $1,000,000. Ohio was the only other State whose sales directly for building exceeded $500,000. Ohio's combined sales for

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building and to dealers, however, amounted to 374,208 tons, valued at $1,484,118, whereas Pennsylvania's were 340,078 tons, valued at $1,264,188. Other States whose sales were valued at more than $100,000 were, in order of rank, Massachusetts, Wisconsin, Connecticut, Virginia, Illinois, Missouri, and Washington. With lime sold to dealers included, Wisconsin ranked next to Ohio with 195,482 tons, valued at $662,104, and Alabama, California, Texas, Indiana, and Tennessee were among the larger producing States. In 9 of the 14 States named above building lime formed 60 per cent or more of the total lime sold, and of them Connecticut, whose sales were almost entirely of building lime, was the only State in which the average price of all lime increased. Of the five States (California, Indiana, Pennsylvania, Tennessee, and Virginia), whose building lime formed 50 per cent or less of the total lime sold, Indiana, Pennsylvania, and Virginia showed an increase in the average price of lime.

Several producers throughout the country reported that the industry was very dull during the first half of the year, but improved during the second half, and especially during the closing months. The outlook for 1916 is very encouraging. Increase in cost of labor and fuel has increased the cost of production during recent years, and keen competition among lime producers and between lime producers and gypsum and cement producers, together with a dull market during 1915, has lowered the selling price of lime, leaving little or no profit for the producer. Some large producers reported operations at a loss in 1915, and several stated that the selling price must be advanced if they are to continue in business.

In Pennsylvania the State laws taxing sales of lime[1] and providing for compensation to employees for injuries have added to the cost of production and are cited by a few producers as the cause of their suspension of operations.

In Maryland some producers were handicapped by a scarcity of box cars for shipping lime and by difficulty in obtaining coal, as well as by a large increase in the cost of coal. Labor conditions were reported to be satisfactory.

Southern Wisconsin and northern Illinois were seriously affected by the unfavorable building conditions in Chicago, which were intensified by a strike of three months' duration in the brick trade. One lime producer stated that this strike alone was responsible for a decrease of 15 to 20 per cent in his sales. The marked fall in average price in these States is largely attributed to keen competition for what trade existed.

Producers in southern California, besides suffering from a decrease in building operations, were seriously affected at the close of the year by heavy rains, which interfered with the manufacture of lime as well as with building.

In the Northwest the industry improved in the relatively small producing States of Oregon, Idaho, and Montana, but declined in the more important State of Washington. Producers in Washington attribute the decline to a continued decrease in the use of lime for building during recent years, owing to a dull market and to competition with other materials; also to inability to compete with pro-

[1] Act No. 306 of the General Assembly, 1915, Pennsylvania: To regulate the sale for agricultural purpose of crushed limestone, lime, gypsum, and related products.

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ducers in British Columbia, who are benefited as they allege, by a low tariff on lime imports into the United States and a higher tariff on imports into Canada, by low cost of Chinese labor, and by low taxes. Reference to the table of imports on page 261, however, shows that total imports from Canada in 1915 amounted to only 3,453,100 pounds, or less than 1,727 tons, valued at $15,290, whereas the lime produced and sold in Washington in the same year was 27,240 tons, valued at $171,023. Competition among domestic producers has resulted in some cutting of prices, although the cost of other commodities has increased. An increase in demand for agricultural lime, but at a low price, was reported.

Other States and large building centers call for no special comment except New York. This State attracts special attention because of the comparatively small sales of lime for building and to dealers. The building market of New York City and vicinity appears to draw the bulk of its supply from Maine, Connecticut, and Pennsylvania, all of which States showed an increase in average price per ton. In New York and vicinity, as elsewhere, the building trade was dull during the first half of 1915, but became very active in the second half, and especially in the last quarter of the year. The influence of the New York market upon the lime industry of several States suggests the desirability of showing the consumption of lime in different commercial centers. Data for this are not now available, but it is hoped that, with the cooperation of producers, figures sufficiently accurate for publication can be compiled.

Besides the prospects for a better market in 1916, recent developments in the building lime trade, by which old objections to lime as a building material are being overcome, are reasons for encouragement. The principal development is the increased use of hydrated lime in preference to lump lime and the greater care and accuracy required in the process of manufacture of hydrated lime. The danger of pitting or "popping" of wall plaster, due to incomplete hydration of lime, is eliminated by the use of thoroughly prepared hydrated lime. At present some manufacturers of lump lime for building are suffering from competition with producers of hydrated lime, but this must be regarded as a necessary incident in a gradual evolution of the industry. Further attention is given to hydrated lime on page 258.

Another interesting development is the introduction of a new type of wet mortar plant that has been in operation for two years in some of the large building centers of the Pacific coast,[1] manufacturing hard-lime mortar, masonry mortar, finishing putty, and other products. The plant buys kiln-run lime in bulk. It is of the continuous type. The lime is drawn from tight storage bin into slaking tank, and after the quicklime has been hydrated or slaked to the consistency of thick cream, it is strained off into curing vats, the lighter fluid into the "plaster vats" and the remainder into the "masonry vats." After aging, the putty is mechanically aerated by violent agitation, after which it flows through a feed valve to mixer. Here it comes in contact with sand and Keene's cement, which also feed continuously and uniformly, the cement discharging into the sand feeder before the sand reaches the mixer. As this mass is

[1] Hay, William C., How lime can be reestablished in the plaster field: Nat. Lime Manufacturers' Assoc. Bull 7—Advance of minutes, April, 1916.

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being churned through the mixer, fiber or hair is fed by a steadily running "draper" to a picking drum, which disintegrates and feeds the hair in finely separated strands into the cold and continuously mixing mass of mortar. From the end of mixer the mortar is elevated to measured steel loading tanks, from the bottom of which auto trucks of 4 cubic yards capacity are loaded by the opening of a gate. The expense of hauling the extra weight of water in the wet mortar is said to be negligible where auto trucks are employed. Imperfections due to carelessness of laborers mixing the mortar or to incomplete slaking of the lime are eliminated, as the finished mortar is delivered ready for spreading. It may, however, like unmixed hydrated lime, be kept for days without noteworthy deterioration.

The plant is designed in different sizes to suit respective cities or towns, and any one plant is fully operated by one workman up to a daily capacity of approximately 50 tons of finished mortar, two workmen for 100 tons, and so on. The latest plant of this type, recently erected in Los Angeles and owned by the Blue Diamond Plaster Co., has a capacity of 250 tons of finished mortar per day of eight hours, with only two laborers and an electric installation of 55 horsepower.[1]

It is estimated that in 1915 these wet mortar plants purchased approximately 8,000 tons of lime from producers, and sold approximately 90,000 tons of mortar, valued at about $270,000, or about $3 a ton.

Chemical works.—Lime for chemical works in 1915 increased both in quantity (34 per cent) and in value (38 per cent), passing all previous records. The average price per ton in 1915 increased 9 cents, as compared with 1914, but was less than that of 1913 ($3.45) by 9 cents. The demand for lime for chemical works in the Eastern States was increased by the European war, but in the Northwest one producer reported an opposite effect.

Lime for chemical works represented nearly one-seventh of the total quantity and value of lime and was sold in 20 States. Pennsylvania was the leading State with 107,407 short tons, valued at $344,201. Other States whose productions were valued at more than $100,000 were, in order of rank, West Virginia, Virginia, Michigan, and New York. The average price of lime increased in all these States except Michigan, where there was a decrease of 2 cents. The proportion of lime for chemical works to the totals of these States ranged from about one-ninth in Pennsylvania to about three-fifths in Michigan.

In addition to burned lime for chemical works there were 1,612,682 tons of limestone, valued at $765,828, sold to alkali works in 1915. This limestone, sold and reported by the producers as stone, is included in the report on stone for 1915.

Paper mills.—Lime for paper mills continued to decrease in both quantity and value in 1915. The quantity sold in 1915 was about 11 per cent less and the value about 14 per cent less than in 1915. The price per ton in 1915, $3.61, was lower by 15 cents than in any of the five preceding years. In spite of this continued decline, one producer reported that the European war has benefited the paper mills, espe-

[1] Information from William C. Hay.

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cially the sulphite pulp mills, as the supply of imported pulp had been stopped. Limestone for paper mills decreased in value from $49,164 in 1914 to $40,588 in 1915.

Lime for paper mills represented about one-twentieth of the total sales in 1915 and was sold in 17 States. Pennsylvania, with 50,657 tons, valued at $165,135, was the only State whose sales exceeded $100,000 in value. New York, Wisconsin, Tennessee, and Indiana each had sales in excess of $50,000.

Sugar factories.—Lime for sugar factories in 1915 increased in both quantity (about 7 per cent) and value (19 per cent) when compared with the figures for 1914, and exceeded sales of previous years with the exception of 1911, when 36,424 short tons, valued at $242,344, was sold. The average price per ton in 1915 was greater by 89 cents than in 1914 and exceeded that of other previous years except 1910, when the average price per ton was $8.14. No noteworthy comments regarding this industry in 1915 were made by producers.

Lime for sugar factories was sold in 16 States. It represented less than 1 per cent of the total quantity of lime sold in 1915 and only 1.6 per cent of the total value. California was the only State whose sales were valued at more than $100,000, and Tennessee, with sales valued at nearly $30,000, was the only other State in which lime for sugar factories formed an important fraction of the total sales. In California the quantity and value of lime for sugar factories exceeded that for any other purpose in 1915; nevertheless the average price of lime in that State decreased 23 cents a ton, due evidently to lower prices of lime for building and for dealers.

As both carbon dioxide and lime are used in the manufacture of sugar, many sugar manufacturers prefer to buy limestone and burn their own lime. In 1915 there were sold to sugar factories, in addition to burned lime, 394,122 tons of limestone, equivalent to about 210,000 tons of burned lime.

Limestone and lime used by sugar factories, 1911–1915.

	1911	1912	1913	1914	1915	
					Quantity (short tons).	Value.
Limestone	$300,717	$335,108	$387,724	$323,796	394,122	$381,038
Lime	242,344	186,164	216,768	187,065	34,025	230,368
	543,061	521,272	604,492	511,401	428,147	611,406

These figures show a greater total value in 1915 than in any of the preceding years and indicate a sudden rise in an industry that has been showing indications of a decline.

Tanneries.—Sales of lime for tanneries in 1915 continued to decline from the record figures of 1913. The quantity sold in 1915 was about 5 per cent less and the value 10 per cent less than in 1914. The average price per ton, which was $4.62 in 1910 and has steadily declined since, dropped 25 cents in 1915 below that of 1914.

Lime for tanneries represented about 1.5 per cent of the total lime sold in 1915, and was sold in 15 States. Vermont was the leading

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State, with sales valued at $41,560. Other States whose sales exceeded $10,000 in value were Pennsylvania, Michigan, Indiana, New York, and Virginia.

Fertilizer.—The quantity of lime for fertilizer in 1915 decreased about 5 per cent in quantity from the record figure of 1914, but was considerably higher than in any other preceding year; the value in 1915, however, was 1 per cent greater than that of 1914, and was the greatest yet attained. The average price per ton increased 18 cents over that of 1914, and was also a record figure. These figures reflect the growing appreciation of the importance of lime in agriculture. In spite of this general increase in demand and value, however, agricultural lime declined markedly in a few States, notably New Jersey. Those especially interested in the importance of lime in agriculture are referred to a recent paper by Wilder.[1]

Lime for fertilizer was sold in 1915 in 29 of the 43 lime-producing States, and represented about one-sixth of the total quantity and one-seventh of the total value of lime sold. Pennsylvania was the leading State with sales valued at nearly $1,000,000. Other States whose sales exceeded $100,000 were Maryland, Ohio, Virginia, and West Virginia. Of the 14 States in which no lime for fertilizer was sold by producers the majority comprise those in semiarid regions where soils need little besides irrigation to make them highly productive, and those that contain extensive areas whose agricultural resources have only recently been developed. One producer in the East reported an increased demand for agricultural lime due to the lack of potash imports, which greatly increased the price of patent fertilizers.

Besides burned lime, there were also sold for fertilizer in 1915 810,399 short tons of pulverized limestone, valued at $893,530, an average price of $1.10 per ton.

Dealers.—Lime sold to dealers in 1915 decreased 8 per cent in quantity and 10 per cent in value, compared with 1914. The average price per ton decreased 10 cents. These figures are not so significant as those for other kinds of lime, as the equivalent of a quantity reported as sold to dealers in one year may be reported as lime for building or for fertilizer in the next year. There is little doubt that a large part of the lime sold to dealers is ultimately used for building, and in this respect the decreases above noted are significant.

Lime was sold to dealers in 29 States during 1915, and represented about one-sixth of the total lime sold. Ohio was the leading State with sales valued at $767,527, more than the value of lime sold for building. Other States with sales valued at more than $100,000 were Missouri, Wisconsin, Pennsylvania, Alabama, Texas, California, and Indiana. In all these States, except Pennsylvania and Indiana, the average price of lime decreased in 1915.

Other uses.—Lime for other uses made remarkable increases of 112 per cent in quantity and 165 per cent in value in 1915 compared with 1914. The average price per ton increased 96 cents. The principal cause of the increase was the larger quantity used by steel works and smelters.

Lime for other uses was sold in 27 States in 1915, representing more than one-ninth of the total quantity and nearly one-seventh of

[1] Wilder, G. J., The importance of lime in agriculture: Nat. Lime Manufacturers Assoc. Bull. 9—Advance of minutes, 1916.

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the total value of lime sold. West Virginia was by far the leading State, with sales valued at $317,065. Ohio, New York, and Pennsylvania also had sales in excess of $100,000.

Besides the kinds of lime usually grouped under "other uses" there was sold in 1915 a limited quantity of magnesian lime for abrasive purposes, replacing the Vienna lime, or *Wienerkalk*, that had heretofore been imported from Europe. This lime, wet with water, is used as a cleaner before nickel plating, but more commonly is mixed with fats or waxes, which serve as lubricants, and is used for polishing nickel-plated work and steel ball bearings, and for similar buffing purposes. The average analysis[1] of the imported lime is as follows:

	Per cent.
Calcium oxide (CaO)	58.6
Magnesium oxide (MgO)	34.7
Carbon dioxide (CO_2)	6.7
Water (H_2O)	Trace
	100.0

Magnesian lime is necessary for use with fats or waxes, as the heat generated by high calcium lime during slaking dries them up. Freedom from silica is also essential. Limes whose analyses are essentially identical with that quoted and which were properly ground, have been tried as substitutes for Vienna lime, but with unsatisfactory results. Just what physical factors determine the adaptability of lime for this kind of abrasive work have not been determined.

Related to the uses of magnesian lime are the manufacture of basic magnesium carbonate and dolomite sinters. Basic magnesium carbonate is extracted from high magnesian, or dolomite, lime, and is used in combination with asbestos for insulating heat. Dolomite sinters are made by burning impure dolomite to a higher temperature than is employed in ordinary lime burning. The sintered dolomite is used in the manufacture of steel as a substitute for imported magnesite, the supply of which has recently become very small.

HYDRATED LIME.

The hydrated lime sold in the United States continues steadily to increase, as shown in the following table:

Hydrated lime manufactured and sold in the United States, 1906–1915.

Year.	Quantity (short tons).	Value.	Average price per ton.	Number of plants reporting operations.
1906	120,357	$479,079	$3.98	30
1907	140,135	657,636	4.69	33
1908	136,411	548,262	4.02	46
1909	204,611	904,900	4.43	50
1910	320,819	1,288,789	4.02	51
1911	304,593	1,372,057	4.50	60
1912	416,890	1,829,064	4.39	64
1913	493,269	2,205,657	4.47	80
1914	515,121	2,239,916	4.35	82
1915	581,114	2,457,602	4.23	84

[1] Furnished by Siemon & Elting, 93–95 Nassau Street, New York, N. Y.

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The quantity and value of hydrated lime sold in 1915 were, respectively, about 13 and 10 per cent greater than in 1914, but the average price per ton fell 12 cents. The increase in quantity was greater than that for 1914 (4 per cent) but considerably less than in the two preceding years (18 per cent in 1913 and about 37 per cent in 1912). The average price per ton, though fluctuating, has on the whole been declining since 1911, when it was $4.50. These changes may suggest that the production of hydrated lime has reached such proportions that its future growth will be at a slower rate than formerly, but as the quantity sold by producers in 1915 amounted to only 16 per cent of the total lime sold, there is ample room for future growth, especially in view of the marked attention now being given to this kind of lime. It should also be noted that the most marked increase in quantity sold was in the prosperous years 1912 and 1913, the number of operating plants being increased by 16 in the latter year, whereas in the comparatively dull years 1914 and 1915 increase in both quantity and value was maintained, though with the addition of only two plants each year. This comparison suggests increase in the average capacity of each plant and in the efficiency of manufacture, and may also account in part for the decline in average price per ton during the last two years; but the average price was also doubtless affected by the dull market for building lime.

The following table draws attention to the steady development of this branch of the lime industry:

Lime-hydrating plants in operation in 1906–1915.

State or Territory.	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915
Alabama	1	1	1	3	2	2	2	2	3	3
Arizona	1	1	1	1	1	1	.....	.....	.....	.....
California	.....	1	2	2	2	3	3	4	2	2
Colorado	.....	1	.....	1	1	.....	.....	.....	.....	.....
Connecticut	1	.....	.....	1	.....	.....	1	.....	1	1
Florida	.....	.....	1	.....	1	.....	.....	1	.....	1
Georgia	2	1	1	.....	.....	1	1	1	.....	.....
Hawaii	.....	.....	.....	.....	1	.....	.....	.....	.....	1
Idaho	.....	.....	.....	1	1	1	1	.....	.....	1
Illinois	.....	1	1	2	2	1	1	1	1	1
Indiana	2	2	2	2	2	2	2	2	3	3
Iowa	1	.....	.....	1	.....	.....	.....	1	1	.....
Kansas	1	1	.....	1	.....	.....	.....	.....	.....	.....
Kentucky	.....	.....	.....	.....	.....	.....	.....	1	1	.....
Maine	1	1	1	1	1	1	1	1	1	1
Maryland	.....	.....	1	1	3	3	3	4	6	5
Massachusetts	.....	.....	.....	.....	1	2	.....	1	1	1
Michigan	1	1	2	1	2	3	1	3	2	3
Missouri	.....	2	2	3	3	3	4	4	6	5
New Jersey	.....	.....	1	1	.....	2	1	1	1	1
New York	1	2	2	3	.....	2	3	4	4	6
North Carolina	.....	.....	.....	.....	.....	1	.....	.....	.....	.....
Ohio	8	9	11	8	11	15	17	19	20	21
Pennsylvania	8	6	11	9	8	8	15	15	14	11
Rhode Island	.....	.....	.....	.....	.....	.....	.....	.....	1	1
South Dakota	.....	.....	.....	.....	1	1	.....	1	1	1
Tennessee	.....	.....	1	1	1	1	1	2	2	2
Texas	.....	.....	1	3	3	3	3	3	3	3
Virginia	.....	.....	1	2	.....	1	.....	2	1	2
Washington	.....	.....	.....	.....	.....	1	1	2	2	2
West Virginia	1	1	1	.....	2	1	2	3	3	4
Wisconsin	1	2	2	2	2	1	1	2	2	2
	30	33	46	50	51	60	64	80	82	84

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The net increase of 2 plants in 1915 is the difference between an increase of 8 plants in 6 States and Hawaii and a decrease of 6 plants in 4 States. New York, with 2 new plants, showed the greatest increase, and Pennsylvania, with 3 less than in 1914, showed the greatest decrease.

An important feature of the hydrated lime industry is the use of hydrated lime for waterproofing concrete. This use has attracted much attention in recent years, especially in 1915, and several examples of its success have been cited. The superiority of hydrated lime over lump lime for building is also receiving broader recognition, due in part to the activity of the Hydrated Lime Bureau, a branch of the National Lime Manufacturers' Association. This bureau has issued a pamphlet of standard specifications for mortars and plasters with a hydrated lime matrix and has also issued instructive general information on hydrated lime. This subject has grown so markedly in public interest that an elaborate series of experiments on the properties and uses of hydrated lime, including its effect upon concrete, has been commenced by the United States Bureau of Standards. In addition to these developments, improvements have been made in lime hydrators and in the design of lime-hydrating plants, and a process for increasing the plasticity or spreading quality of hydrated lime by the addition of a limited quantity of clay during hydration has been patented by W. E. Carson (U. S. patent No. 1,184,320, dated May 23, 1916).

The following is a list of the more important articles on hydrated lime and its uses which have recently come to the writer's attention:

Hydrated lime, by E. W. Lazell, 95 pages. Published by Jackson-Remlinger Printing Co., Pittsburgh, Pa., 1915; distributed by the Hydrated Lime Bureau, Pittsburgh, Pa. (A general elementary text on the history, chemistry, manufacture, properties, and uses of hydrated lime.)

Hydrated lime, by W. B. Joseph: Cement and Engineering News, February, 1915, pp. 45–46. (A brief account of the processes of manufacture and properties of hydrated lime.)

Effect of adding hydrated lime (to Portland cement): Cement and Engineering News, March, 1915, p. 76. (Cites experiments by Henry S. Spackman, who concluded "that the addition of hydrated lime will be found advantageous under ordinary climatic conditions in concrete work generally, where it is exposed either to air or to fresh water; and concrete to which such additions have been made, besides being more impermeable, will show less change in volume under varying moisture content.")

Papers read at the Thirteenth annual meeting of the National Lime Manufacturers' Association and published in the minutes of the meeting, February, 1915: Hydrated lime plastering—the fourth year's development, by Lawrence Hitchcock; the possibilities of hydrated lime products for plastering purposes, by H. S. Spackman; hydrated lime in Oregon State roads, by R. S. Edwards; hydrate as an addition to concrete, by E. M. Soper; a modern hydrating plant, by R. K. Meade.

A modern hydrated lime plant, by R. K. Meade: Cement and Engineering News, June, 1916, pp. 132–135.

Advantages in use of commercially hydrated lime over ordinary slacked lime, by E. W. Lazell: Cement and Engineering News, June, 1915, pp. 125–126.

Perfecting concrete roads—the part that hydrated lime plays in assuring absolute permanency to concrete, by Charles Warner: Cement and Engineering News, September, 1915, pp. 198–200.

Standard specifications for hydrated lime plastering. Pamphlet E, 1915: Hydrated Lime Bureau of the National Lime Manufacturers' Association, Pittsburgh, Pa.

Tests and uses of hydrated lime, by R. C. Haff: Cement Era, February, 1915.

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Papers read at the Fourteenth annual meeting of the National Lime Manufacturers' Association, Cleveland, Ohio, February, 1916 (to be published in the minutes of the meeting):

Use of lime in stuccos and rich mortars, by A. H. White; chemically correct hydrate of lime on a commercial basis, by W. Crow.

IMPORTS.

Imports of lime for consumption in the United States in 1915 were reported by the Bureau of Foreign and Domestic Commerce as 1,956 short tons, valued at $22,489 at port of entry, as compared with 3,455 short tons, valued at $33,670, in 1914, a decrease in quantity of 1,499 tons and in value of $11,181. The quantity of imports continues steadily to decrease and has been insignificant for some years.

The following table of general imports was compiled from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce:

General imports of lime into the United States in 1915.

Country.	Quantity (pounds).	Value.	Country.	Quantity (pounds).	Value.
Germany	604,000	$5,547	Hongkong	200	$2
England	2,300	134	Japan	1,000	11
Canada	3,453,100	15,290			
Mexico	227,800	723		4,228,400	21,707

The average prices per ton according to this table are: Germany, $18.27; England, $116.50; Canada, $8.76; Mexico, $6.35; Hongkong, $20; and Japan, $22. These prices indicate that imports from other than North American countries are of specially prepared limes or of limes with certain recognized properties that adapt them to special uses. There is no apparent reason why domestic limes adapted to such uses can not supply this limited demand, provided they are so situated with respect to markets that they can compete with foreign limes.

EXPORTS.

Exports of lime steadily increased in recent years, both in quantity and in value, until 1913, when they amounted to 294,746 barrels, valued at $212,345, or 1.45 per cent of the total value of domestic production. In 1914, however, they dropped to 241,406 barrels, valued at $170,744, and in 1915 to 162,229 barrels, valued at $106,312, at ports of shipment. The average prices per ton in these years were $7.20 in 1913, $7.07 in 1914, and $6.55 in 1915. The value of exports in 1915 was 0.7 per cent of the value of domestic production.

The figures in the following table were furnished by the Bureau of Foreign and Domestic Commerce, United States Department of Commerce.

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Exports of lime from the United States in 1915.

Country.	Quantity (barrels of 200 pounds).	Value.	Country.	Quantity (barrels of 200 pounds).	Value.
Canada	148,458	$82,258	West Indies—Continued.		
Newfoundland	10	17	Bermuda	2	$4
Mexico	5,201	6,103	Other British West Indies	133	259
Central America:			South America:		
Gautemala	38	40	Colombia	18	39
British Honduras	48	49	British Guiana	12	34
Honduras	1,086	996	Dutch Guiana	86	180
Nicaragua	861	989	Peru	463	1,039
Panama	1,384	2,225	Argentine	208	467
West Indies:			Uruguay	60	124
Cuba	153	255	England	1,408	4,351
Haiti	11	20	Australia	4	12
Dominican Republic	1,488	4,483	New Zealand	270	555
Danish West Indies	566	1,276	French Oceania	36	49
French West Indies	22	72			
Barbados	213	446		162,229	106,312

FUELS.

The statistical inquiry of the Survey into the efficiency of various fuels in burning lime has yielded some results, though far from what could be wished. Information obtained from operations in 1915 does not alter the data already published. These data are not sufficient to make reliable averages, for many producers have not replied to the inquiry; and although some have given figures evidently based on measurements, others have sent what appear to be mere guesses. Many lime manufacturers have no very accurate idea themselves as to the quantity of lime produced from a given quantity of fuel. The reports, however, are of interest, and something can be gleaned from them.

A movement has recently been started by the National Lime Manufacturers' Association to adopt a uniform system of cost keeping. It is hoped that some method of accounting will be devised by which the fuel efficiency will be more accurately known and that the statistics here published will become more accurate every year.

Reports on the quantity of lime burned by 1 pound of coal ranged, according to the kind of coal used, from 1.5 to 6 pounds, but the average was about 3.6 pounds. Coke used as fuel for burning lime averaged (in the few reports received) 4.2 pounds of lime to 1 pound of coke. Producer gas is used in a few plants, and what little information was received on its use shows that producer gas burns from 3 to 4.1 pounds of lime and averages about 3.4 pounds of lime burned to 1 pound of coal converted into producer gas.

Wood reported as a fuel showed a range from 1,000 to 6,400 pounds of lime burned by a cord of wood. In spite of this wide range, the data are believed to be sufficient for an approximate average. The figures submitted by producers show that 1 cord of wood burns approximately 4,000 pounds of lime and that the quantity varies with the kind of wood used.

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Number of kilns using various kinds of fuel in 1914 and 1915.

1914.

State or Territory.	Coal.	Wood.	Oil.	Natural gas.	Producer gas.	Coke.	Shavings.	Coal and wood.	Coal and coke.	Total.
Alabama	8	10			8			9		35
Arizona	7									7
Arkansas		11						2		13
California		7	36			3				46
Colorado	3	1				1				5
Connecticut	9	26								35
Florida		19								19
Georgia								2		2
Hawaii			2							2
Idaho		5				2				7
Illinois	8	6		1			21	12		48
Indiana	44	1								45
Iowa		5								5
Kentucky	8	4								12
Maine	41	14					5			60
Maryland	87	3				39		7	1	137
Massachusetts	9	9			6			20		44
Michigan		32			1					33
Minnesota	8	6								14
Missouri	28	31			2			23		84
Montana		7								7
Nevada			2							2
New Jersey	19	1								20
New Mexico	1							1		2
New York	39	10			1			8		58
North Carolina	1							4		5
Ohio	206	10		33	55	5		6		315
Oklahoma		4								4
Oregon		2						1		3
Pennsylvania	797	19			2	32	3	20	25	898
Rhode Island	2									2
South Dakota	2	4								6
Tennessee	26	1				1		6	1	35
Texas	1	12	7	2	4	5				31
Utah	7	5				7				19
Vermont		8			4			8		20
Virginia	44	20				29		24		117
Washington		23								23
West Virginia	28	3			3	44		4		82
Wisconsin	3	101								104
	1,436	420	47	36	86	168	29	157	27	2,406

1915.

Alabama	5	8			8	1		20		41
Arizona		6								6
Arkansas		12								12
California		11	25			7				43
Colorado	5									5
Connecticut	5	20			2					27
Florida		19								19
Georgia		1								1
Hawaii		2								2
Idaho		5				1				6
Illinois	4	4			1		25			34
Indiana	45	1			2					48
Iowa		5								5
Kentucky	2	3								5
Maine	38	11								49
Maryland	59					51		6	14	130
Massachusetts	10	8			7			20		45
Michigan		26			1			4		31
Minnesota	6	7								13
Missouri	23	23			2			18		66
Montana		7								7
Nevada			2							2
New Jersey	18	1								19
New Mexico	2	1								3
New York	35	15						4		54
North Carolina	1							4		5
Ohio	208	8		38	45			5		304
Oklahoma		2								2
Oregon		2								2
Pennsylvania	684	16		3	4	124		52	31	914

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Number of kilns using various kinds of fuel in 1914 and 1915—Continued.

1915—Continued.

State or Territory.	Coal.	Wood.	Oil.	Natural gas.	Producer gas.	Coke.	Shavings.	Coal and wood.	Coal and coke.	Total.
Rhode Island	1									1
South Carolina		1								1
South Dakota	2	4	2							8
Tennessee	29	7						6	1	43
Texas	3	4	7	2		5		4		25
Utah	7	3				7				17
Vermont		3			4			9		16
Virginia	36	18			3	33		18	11	119
Washington		12								12
West Virginia	25	1			3	40		4	1	74
Wisconsin	113				2					115
Wyoming								1		1
	1,366	277	36	43	84	269	25	175	58	2,333

According to this table there was a marked decrease in the number of kilns burning wood and of those burning coal, a marked increase in the number burning coke, and a moderate increase in the number using coal and wood or coal and coke. The decrease in the use of wood as a fuel is due chiefly to its increasing cost and scarcity, as wood has long been recognized as the best fuel for the burning of lime. The relative merits of burning lime with wood, coal, coal gas, and natural gas form the subject of a recent paper by W. E. Emley.[1]

[1] Read before the Fourteenth meeting of the National Lime Manufacturers' Association, Cleveland, Ohio, 1916.

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SALT, BROMINE, AND CALCIUM CHLORIDE.

By W. C. PHALEN.[1]

SALT.

PRODUCTION.

The marketed production of salt in the United States in 1915, including Hawaii and Porto Rico, was 38,231,496 barrels[2] or 5,352,409 short tons, valued at $11,747,686, an increase of 3,426,813 barrels or

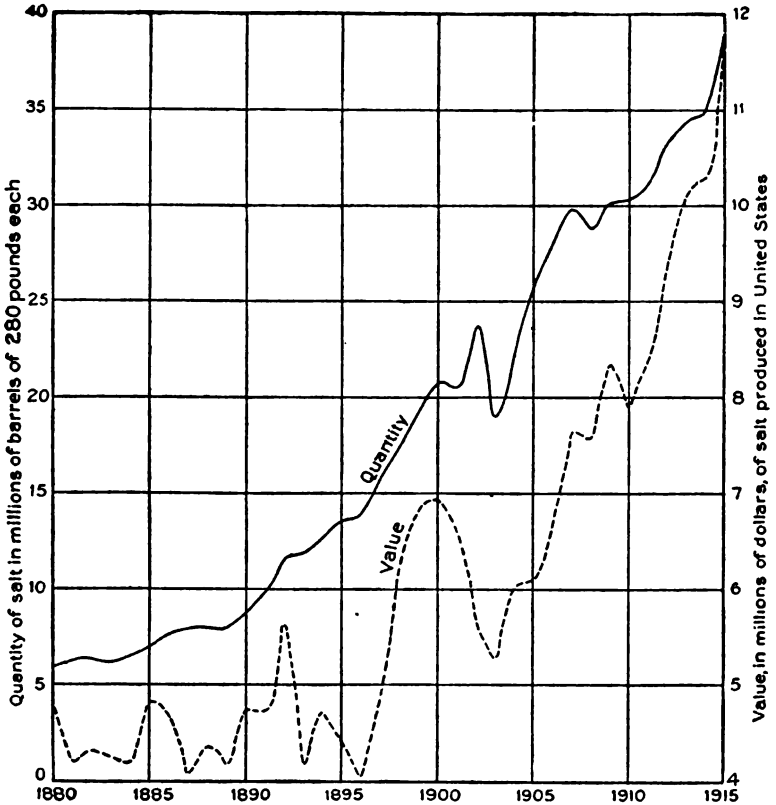

FIGURE 12.—Curves showing increase in quantity and value of salt produced in the United States, 1880–1915.

479,753 short tons in quantity and of $1,550,269 in value, as compared with 1914. Expressed in percentage the increase was 10 per cent in quantity and 15 per cent in value.

[1] The statistical tables were compiled by Miss A. T. Coons, statistical clerk.
[2] The barrel containing 280 pounds and the short ton are the units of measure chiefly used in the salt industry.

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The average price of salt in 1915 was 31 cents per barrel or $2.19 per ton, as compared with 29 cents per barrel or $2.09 per ton in 1914. During the last five years the price of salt, as well as the marketed production, has been slowly increasing, as will be observed from the curve and table of production.

The United States furnishes nearly all the salt consumed by its people. In 1915 it produced 99 per cent of its requirements and it could easily supply them all if conditions required it. For many years the country has been able to supply the domestic demand as the capacity of both mines and manufacturing plants is about 25 per cent in excess of the actual output. Many plants which have worked at fractional capacity or have been entirely shut down in recent years could easily resume operations should the demand warrant.

Great strides have been taken in recent years in methods of making high-grade salt both by the grainer and the vacuum pan processes. The mechanical grainers, in which the brine enters the plant and is not touched by hand till it is almost ready for shipment, are marvels of ingenuity. Fine table salt is now made almost exclusively by the vacuum pan processes. These evaporators have so reduced the cost of making fine salt that the old-time methods have long since been abandoned.

Fourteen States reported production in 1915. Salt of all grades is made, from the lump salt used in salting cattle to the finest grades for table and dairy. Salt is produced from natural and artificial brines, from the waters of Great Salt Lake and of the Pacific Ocean, and is mined as rock salt in New York, Michigan, Kansas, and Louisiana.

It may be said of this commodity that the supplies are apparently inexhaustible and that the United States can not only supply her own needs, but those of the world for a long time to come.

Salt sold in the United States, 1880–1915, in barrels of 280 pounds.

Year.	Quantity manufactured (evaporated).	Quantity of brine (sold as such or used by chemical works).	Quantity of rock salt.	Total quantity.	Total value.	Average price per barrel.
1906	13,725,174	9,573,680	4,873,526	28,172,380	$6,658,350	$0.24
1907	14,672,329	9,222,471	5,809,328	29,704,128	7,608,323	.26
1908	14,791,635	8,869,216	5,161,211	28,822,062	7,553,632	.26
1909	15,398,118	8,770,807	5,938,721	[a]30,107,646	8,343,831	.28
1910	13,950,492	9,389,226	6,965,938	[a]30,305,656	7,900,344	.26
1911	14,924,350	10,027,411	6,232,207	[a]31,183,968	8,345,092	.27
1912	14,824,428	11,408,623	7,091,757	[a]33,324,808	9,402,772	.28
1913	15,223,063	11,588,444	7,587,791	[a]34,399,298	10,123,139	.29
1914	15,422,097	11,805,414	7,577,172	[a]34,804,683	10,197,417	.29
1915	16,684,456	13,222,848	8,324,192	[a]38,231,496	11,747,686	.31

[a] Includes production of Hawaii and Porto Rico, 1909–1913, and 1915, and of Porto Rico, 1914.

GENERAL STATISTICS.

The following table presents in concise form general statistical information of interest to the salt trade:

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Operating salt plants, rank of States, and average price per ton in 1914 and 1915, and percentage of increase or decrease in 1915.

State.	1914				1915				Percentage of increase or decrease in 1915.	
	Number of operating plants.	Rank of State by—		Average price per ton.	Number of operating plants.	Rank of State by—		Average price per ton.	Quantity.	Value.
		Total quantity.	Total value.			Total quantity.	Total value.			
California	[a] 24	6	5	[b] $7.00 [c] 5.08	[a] 25	7	5	[b] $3.98 [c] 4.73	− 4.7	−19.0
Hawaii					[c] 1	12	11	[c] 8.00		
Idaho	[c] 3	16	15	[c] 12.38	[c] 1	16	16	[c] 10.00	− 76.1	−80.7
Kansas	[a] 10	4	4	[b] 1.29 [c] 3.24	[a] 10	4	4	[b] 1.34 [c] 2.55	+ 26.9	+12.0
Louisiana	[b] 2	5	6	[b] 2.29	[b] 2	5	6	[b] 2.52	+ 9.7	+20.9
Michigan	[a] 26	1	1	[b] 2.56 [c] 1.99	[a] 27	1	1	[b] 2.02 [c] 2.43	+ 7.9	+30.5
Nevada	[c] 3	14	14	[c] 3.94	[c] 3	14	14	4.07	+ 56.2	+61.4
New Mexico	[c] 1	13	13	[c] 7.00	[c] 1	13	13	[c] 2.76	+185.7	+10.4
New York	[a] 27	2	2	[b] 1.91 [c] 1.96	[a] 26	2	2	[b] 1.95 [c] 1.86	+ 8.0	+ 5.2
Ohio	[c] 10	3	3	[c] 1.72	[a] 10	3	3	[c] 1.78	+ 7.2	+10.7
Oklahoma	[c] 2	15	16	[c] 3.69	[c] 2	15	15	[c] 6.91	− 39.6	+13.1
Pennsylvania	[c] 1	12	12	[c] 5.25						
Porto Rico	[c] 2	11	11	[c] 2.89	[c] 2	11	10	[c] 2.57	+ 17.8	+ 4.9
Texas	[c] 3	9	7	[c] 5.36	[c] 5	8	7	[c] 5.55	+ 32.8	+37.6
Utah	[a] 6	8	8	[b] 2.81 [c] 4.61	[a] 7	9	8	[b] 2.29 [c] 5.04	+ 5.2	+15.0
Virginia	[c] 1	7	10	[d] .36	[c] 1	6	12		+ 17.3	
West Virginia	[c] 3	10	9	[c] 3.83	[c] 4	10	9	[c] 3.54	+ 59.7	+47.6
Total brine and rock salt	124			[b] 1.91 [c] 2.14	127			[b] 1.97 [c] 2.26	[b] + 9.9 [c] + 9.8	[b] +13.6 [c] +15.6
Total United States				2.09				2.19	+ 9.8	+15.2

[a] Includes both rock and brine salt.
[b] Rock salt.
[c] Brine salt.
[d] The low value of salt in Virginia is due to the fact that the salt is in the form of brine, which is not utilized for its salt content, but is worked up into other sodium salts.

PRODUCTION BY GRADES.

Salt occurs naturally in two very distinct ways—(1) as rock salt in beds or associated with bedded or sedimentary deposits and (2) as natural brines. The larger part of our production of salt is derived by converting the rock salt into artificial brines, which are pumped to the surface and there evaporated.

The two methods of production are (1) the mining of rock salt and its purification and separation into marketable sizes and (2) the production of salt by evaporation of artificial or natural brines and of sea water.

The principal processes hitherto employed in the manufacture of salt by evaporation are: (1) Solar evaporation, (2) direct heat evaporation in open kettles or in open pans, (3) steam evaporation in jacketed kettles or in grainers, (4) vacuum-pan evaporation. Of the classes enumerated, direct-heat evaporation in open kettles and steam evaporation in jacketed kettles have become practically obsolete.

In addition to the marketable salt thus produced, a very considerable quantity of sodium chloride does not enter the market as such, but is converted directly into sodium carbonate or bicarbonate or other sodium salts and is sold in these forms.

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BRINE SALT.

By the processes mentioned above are produced the different grades of salt made from brine, together with many modifications of them put on the market under different trade and proprietary names.

Brine salt marketed in the United States, 1911–1915.

Year.	Table and dairy.		Packers' salt.					
			Common fine.		Common coarse.		Packers'.	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1911	3,773,798	$2,528,671	6,267,850	$2,048,527	2,970,492	$1,041,619	408,928	$162,945
1912	3,961,450	3,164,638	6,021,052	2,109,076	2,753,375	1,096,643	751,551	296,238
1913	3,881,387	3,223,336	6,521,058	2,423,012	3,464,978	1,414,760	(a)	(a)
1914	4,121,574	3,221,007	6,237,860	2,383,588	3,789,163	1,453,484	.....	.....
1915	4,341,063	3,720,020	7,013,065	2,762,450	3,834,101	1,794,503	.....	.....

Year.	Coarse solar.		Other grades.		Brine.		Total.	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1911	1,343,046	$444,324	160,233	$40,365	10,027,411	$501,225	24,951,758	$6,767,676
1912	1,105,935	408,939	231,063	59,093	11,406,623	570,316	26,233,049	7,704,943
1913	1,161,649	446,342	193,991	67,608	11,588,444	579,014	26,811,507	8,154,572
1914	1,080,199	451,206	193,301	73,715	11,805,414	589,519	27,227,511	8,172,519
1915	1,161,208	508,402	335,019	130,452	13,222,848	601,965	29,907,304	9,447,792

[a] A small output reported directly as packers' is included under common coarse.

ROCK SALT.

Rock salt marketed in the United States, 1911–1915.

Year.	Rock salt.	
	Quantity (short tons).	Value.
1911	[a] 872,509	$1,578,016
1912	[b] 992,846	1,697,829
1913	[b] 1,062,291	1,968,567
1914	[b] 1,060,804	2,024,898
1915	[b] 1,165,387	2,299,894

[a] Includes California, Idaho, Kansas, Louisiana, Michigan, New York, and Utah.
[b] Includes California, Kansas, Louisiana, Michigan, New York, and Utah.

Rock salt is produced by deep-shaft mining in the eastern, central, and southern parts of the United States. The 9 active mines are located, 1 each at Retsof and at Halite, Livingston County, N. Y.; 1 near Detroit, Mich.; 3 at Kanopolis, Ellsworth County, and 1 at Lyons, Rice County, Kans.; and 1 each at Weeks and Avery islands, Iberia Parish, southern Louisiana.

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Rock salt occurs near the surface in consequence of the dry climate, and is mined in open cuts or pits in Sevier Valley near Redmond, in both Sevier and Sanpete counties, Utah. A small production of rock salt from near the surface is also reported near Ward, San Bernardino County, Cal. Some rock salt has been produced as the result of development work by the Avawatz Salt & Gypsum Co., in the Avawatz Mountains, San Bernardino County, Cal.

PRODUCTION BY STATES.

Salt of domestic production marketed in the United States, 1912–1915.

State.	1912		1913		1914		1915	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
Michigan	10,946,739	$2,974,429	11,528,800	$3,293,032	11,670,976	$3,299,005	12,588,788	$4,304,731
New York	10,527,221	2,615,334	10,780,514	2,865,187	10,389,314	2,824,733	11,217,471	2,976,405
Ohio	5,269,179	1,364,136	5,310,135	1,318,156	5,482,836	1,320,55a	5,880,243	1,462,192
Kansas	2,573,626	844,292	2,698,079	880,494	2,967,864	924,550	3,765,164	1,035,879
California	1,090,000	620,196	1,082,993	759,485	1,100,443	782,920	1,048,457	694,070
West Virginia	139,121	66,023	113,921	63,803	145,429	78,036	232,239	115,143
Texas	373,064	290,328	355,529	278,008	334,979	251,493	444,978	345,944
Utah	283,293	154,734	330,443	191,686	375,457	231,512	394,850	266,334
Hawaii	8,266	9,180	6,071	5,950	.....	.....	(a)	(a)
Idaho	(a)	(a)	(a)	(a)	300	520	(a)	(a)
Nevada	12,536	15,752	8,971	7,947	4,436	2,448	6,929	3,950
Other States	b2,101,743	448,368	b2,183,842	479,481	c2,332,649	481,646	d2,652,377	543,038
Total	33,324,808	9,402,772	34,399,298	10,123,139	34,804,683	10,197,417	38,231,496	11,747,686

a Included in "Other States."
b Includes Idaho, Louisiana, New Mexico, Oklahoma, Pennsylvania, Porto Rico, and Virginia.
c Includes Louisiana, New Mexico, Oklahoma, Pennsylvania, Porto Rico, and Virginia.
d Includes Hawaii, Idaho, Louisiana, New Mexico, Oklahoma, Porto Rico, and Virginia.

DOMESTIC CONSUMPTION.

The following table shows that the United States furnished very nearly all the salt consumed by its people in 1915. The excess of consumption over production was only 299,944 barrels, or 0.8 per cent. Of course part of our domestic production was exported, but the exports were more than offset by imports which, as shown in the table, were 2.3 per cent of the total consumption.

Supply of salt for domestic consumption, 1890–1915, in barrels.

Source.	1890	1900	1910	1913	1914	1915
Domestic production	8,876,991	20,869,342	30,305,656	34,399,298	34,804,683	38,231,496
Imports	1,838,024	1,427,921	979,305	1,105,466	934,319	873,760
Total	10,715,015	22,297,263	31,284,961	35,504,764	35,739,002	39,105,256
Exports	17,597	53,650	350,094	502,065	587,818	574,816
Domestic consumption	10,697,418	22,243,613	30,934,867	35,002,699	35,151,184	38,531,440
Comparison with preceding year	+877,610	+1,274,634	+46,032	+1,125,012	+148,485	+3,380,256
Percentage of imports to total consumption	17.2	6.4	3.2	3.2	2.7	2.3

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IMPORTS.

According to figures obtained from the Bureau of Foreign and Domestic Commerce, Department of Commerce, the quantity and value of the salt imported and entered for consumption into the United States in the last five years are as follows:

Salt imported and entered for consumption in the United States, 1911–1915.

Year.	In bags, barrels, and other packages.		In bulk.		For the purpose of curing fish.		Total quantity (pounds).	Total value.
	Quantity (pounds).	Value.	Quantity. (pounds).	Value.	Quantity (pounds).	Value.		
1911	61,648,200	$181,405	106,055,700	$95,801	114,475,300	$97,824	284,179,200	$375,030
1912	57,453,400	179,199	133,080,800	112,749	89,091,700	78,700	279,625,900	370,648
1913	70,433,300	209,752	185,743,900	160,400	[a] 53,353,300	[a] 51,593	309,530,500	421,745
1914	65,614,400	212,349	195,994,500	168,454	.....	.....	261,608,900	380,803
1915	57,449,100	196,593	187,203,600	169,859	.....	.....	244,652,700	366,452

[a] This class was not carried separately after Oct. 3, 1913.

EXPORTS.

The exports of salt in 1915 were 160,948,389 pounds (574,816 barrels), valued at $613,850. Though the quantity exported decreased 3,640,623 pounds (13,002 barrels), the value of the exports advanced considerably even as compared with the much larger quantity exported in 1914.

Salt of domestic production exported from the United States, 1911–1915.

Year.	Quantity (pounds).	Value.
1911	97,745,833	$335,285
1912	124,819,713	418,525
1913	140,578,092	515,194
1914	164,589,012	586,055
1915	160,948,389	613,850

SALT INDUSTRY, BY STATES.

CALIFORNIA.

California ranked sixth among the States in quantity and fifth in value of the salt produced in 1915. The quantity produced was 1,048,457 barrels (146,784 tons), valued at $694,070, a decrease of 51,986 tons in quantity and of $88,850 in value, compared with 1914.

There was little of special interest in the California salt industry in 1915. One producer in Alameda County reported a shortage caused by flood conditions. The Avawatz Salt & Gypsum Co. reported some development work on their rock-salt deposits in the Avawatz Mountains, San Bernardino County, and a new company, the Milligan Salt Co., reported having done experimental work at Milligan, San Bernardino County. Some salt was produced by John H. Keyes, about 9 miles east of Suisun, Solano County. The salt is obtained by solar evaporation from brine that issues from a gas well owned by the Rochester Oil Co.

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The salt industry in California is different from that in the other parts of the country. The great bulk of the output in this State comes from sea water. The salt "crop," so called, is "harvested" chiefly in the fall, and its size depends to a large extent on the weather.

The basic salt output in California is chiefly solar salt, and its sale either in the harvested form or after it has been crushed (half ground) or washed and ground for table and dairy use and is known as granulated, constitutes about 80 per cent of the trade. Three firms on the coast recrystalize their product. The cost of crude solar salt in the stack is fairly well established at $2.50 a ton. The price received f. o. b. shipping point, will vary with the varying demands of the industries supplied. The highest grades of salt, such as table and dairy, have practically a uniform market at all times and are not subject to the fluctuation of crude solar salt. The other grades marketed for curing hides, hay, fish, and for making ice cream, have varying prices, according to the work necessary to get them into condition for the market.

The headquarters of the salt industry in 1915 were at Alvarado, Newark, Mount Eden, Russell, and Baumberg (formerly Arffs), in Alameda County, on the east shore of San Francisco Bay, and at Redwood City and San Mateo, in San Mateo County, on the west side of the bay. In the southern part of the State solar salt was made near Long Beach, Los Angeles County, and at the head of San Diego Bay, San Diego County.

Coarse solar salt was also produced inland at Tramway (Keeler post office), Inyo County; Saltdale, Kern County; and at Cedarville, Modoc County. Some rock salt was produced at Ward, San Bernardino County.

IDAHO.

Salt was made by only one operator in Idaho in 1915 and the production came from Stump Creek, Bannock County, in the southeastern part of the State.

KANSAS.

Kansas ranked fourth among the States both in the quantity and the value of the salt marketed in 1915. The quantity produced was 3,765,164 barrels (527,123 tons), valued at $1,035,879, an increase of 797,300 barrels (111,622 tons) in quantity and of $111,329 in value, compared with 1914. Ten companies operated salt plants and mines in Kansas in 1915. Four companies mined rock salt, 3 mines being at Kanopolis, Ellsworth County, and 1 at Lyons, Rice County. Evaporated salt, that is, salt made in open pans, grainers, or vacuum pans, was produced by operators at Hutchinson, Reno County, which may be considered the main headquarters of this branch of the industry, at Anthony, Harper County, and at Lyons, Rice County. The Sterling Salt Co., which for many years has operated at Sterling, Rice County, did not produce in 1915, and reported no sales of salt left over from 1914.

The Short Grass Oil & Gas Co. reports that it has developed 600 feet of rock salt in a well in the SE. ¼ sec. 10 in the northwest township of Clark County, Kans. (T. 30 S., R. 25 W.). The top of the salt was struck at a depth of 690 feet and the topmost stratum of salt is 60 feet thick and is capped by limestone 12 feet in thickness. The next lower

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bed of salt is 158 feet thick with a thin bed of limestone between it and the overlying salt bed. Below this thick bed the salt layers vary in thickness from 5 to 30 feet. No water was encountered in the well from 500 to 2,900 feet, at which depth a small quantity of salt water was found in sand. From 3,300 to 3,700 feet a great deal of strong brine was encountered and the well caved, making it necessary to case down to about this lower level.

LOUISIANA.

Louisiana ranked fifth among the States in quantity and sixth in the value of the salt produced in 1915. Only two companies operated in the State, and to keep the returns of these companies confidential the total output of the State can not be given separately. Only rock salt was produced, which came from Averys Island (Petite Anse) and Weeks Island (Grand Cote).

The most important salt deposits of Louisiana are on the Five Islands, so called, near the southern coast. From two of these—Weeks Island (Grand Cote) and Averys Island (Petite Anse)—a large quantity of rock salt is produced. The only limit to the output of Louisiana salt is the demand, as the State can add greatly to its present production.

MICHIGAN.

Michigan ranked first among the States both in the quantity and the value of the output of salt in 1915. The quantity of salt produced was 12,588,788 barrels (1,762,430 tons), valued at $4,304,731, an increase of 917,812 barrels (128,494 tons) and of $1,005,726 in value compared with 1914.

The salt produced in Michigan is obtained (1) from rock salt and (2) from natural brines.

The rock-salt deposits now worked are in the southeastern and the western parts of the Lower Peninsula and are exploited in two ways: (1) Rock salt itself is actually mined from the deposits, and (2) water is allowed to come into contact with the salt and the brine thus formed, which may be considered artificial, is forced to the surface and there evaporated.

The salt industry of Michigan dependent on the natural brines is confined to the Saginaw Valley. The brine is entirely distinct, not only in its geographic but also in its geologic relations, from the salt in the southeastern and the western parts of the Lower Peninsula. With the salt production in the Saginaw Valley are connected the bromine and the calcium chloride industries. The manufacture of salt in Saginaw Valley is not so important as it is in the other parts of the Lower Peninsula.

Rock salt is mined at Oakwood, near Detroit, Wayne County. In the southeastern part of the State evaporated salt is made at Marine City, Port Huron, and St. Clair, in St. Clair County; at Oakwood, in the suburbs of Detroit; and at Delray, Ecorse, and Wyandotte, in Wayne County. In the western part of the State evaporated salt is made at Eastlake, Filer City, and Manistee, in Manistee County, and at Ludington, in Mason County. The R. G. Peter Salt & Lumber Co., which has operated for many years at Eastlake, near Manistee, reported no sales of salt in 1915. In the Saginaw Valley salt is made at Bay City, Bay County; Mount Pleasant, Isabella County; and at

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Carrollton, Saginaw, and St. Charles, in Saginaw County. Calcium chloride is also made at Mount Pleasant and Saginaw, and bromine at Midland, Mount Pleasant, Saginaw, Bay City, and St. Charles.

The bromine manufactured in Michigan is placed on the market partly as such and partly in the form of bromides. The demand from abroad has greatly stimulated the manufacture of bromine, and plants at Saginaw have engaged in the industry. After a lapse of some years in which no bromine was made, the bromine industry has again started up at St. Charles.

NEVADA.

The production of salt in Nevada in 1915 was 6,929 barrels (970 tons), valued at $3,950. This small production came from Sand Springs, near Fallon and from the Desert Crystal Salt Co., White Plains, Churchill County; and from the Buffalo Salt Works, Sheepshead, Washoe County. The Buffalo Salt Works are located in T. 32 N., R. 20 E., Mount Diablo meridian. C. W. Kinney, of Sand Springs, reports that the salt deposits in that locality are located 24 miles from the railroad but that a line is being built to the salt deposits which will be completed during 1916. A factory will also be built.

NEW MEXICO.

A production of salt was reported by the New Mexico Salt Co., at Lucy, Torrance County, N. Mex.

NEW YORK.

New York ranked second among the States in both quantity and value of the salt produced in 1915. The output was 11,217,471 barrels (1,570,446 tons), valued at $2,976,405, an increase of 828,157 barrels (115,942 tons) in quantity and of $151,672 in value. The output of the State falls into the several usual classes: Rock salt was mined at Halite (Cuylerville post office) and at Retsof, Livingston County; solar salt was produced in the vicinity of Syracuse, Onondaga County, but the crop in 1915 was the poorest in several years; brine utilized in the manufacture of soda products came from Tully, Onondaga County; evaporated salt, or salt made by artificial evaporation in open pans, grainers, or vacuum pans, from brines obtained by allowing water to come into contact with the rock salt in place, is the most important class made in the State and it was made at Le Roy, Genesee County; Piffard, Livingston County; Watkins, Schuyler County; Ithaca and Myers, Tompkins County; and at Rock Glen, Silver Springs, and Saltvale, Wyoming County.

On the whole the New York salt trade was much better in 1915 than in 1914, due in part to the falling off in competition from foreign salt along the Atlantic seaboard.

OHIO.

Ohio ranked third among the States in both quantity and value of output of salt in 1915. The quantity produced was 5,880,243 barrels (823,234 tons), valued at $1,462,192, an increase of 379,407 barrels (55,651 tons) in quantity and of $141,638 in value, compared with 1914.

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The salt came from two districts, one in northeastern and the other in southeastern Ohio. In northeastern Ohio the salt was produced at Cleveland, Cuyahoga County; Wadsworth, Medina County; Akron, Summit County; and Rittman, Wayne County. Brine is pumped at Fairport Harbor, Lake County, and at Barberton, Summit County, and is used directly in the manufacture of soda. The brine utilized in making salt and soda is obtained by allowing water to come into contact with beds of salt. In southeastern Ohio, Pomeroy, Meigs County, is the center of the industry, and in addition to salt, bromine and calcium chlorides are also produced from the natural brines.

OKLAHOMA.

The small production of salt in Oklahoma in 1915 came from Harmon County. The salt plains of Harmon County are located in small canyons in the gypsum hills south of Elm Fork of Red River, about 5 miles east of the Texas border and 1½ miles south of the north line of the county. The plains are known locally as the Chaney or Salton salt plain and the Kiser salt plain. They are both small, neither covering an area of more than an acre, and they are not more than a mile apart. The salt is contained in spring water that issues from shallow beds occurring below gypsum. Springs also boil up from the level floor of the plains. A local industry has been carried on for many years in this region at the old Kiser Salt Works. The springs farther west, and now known as the Salton salt beds have been worked for the last five years. Salt for stock is produced at both places.

TEXAS.

The production of salt in Texas in 1915 was 444,978 barrels (62,297 tons), valued at $345,944, an increase of 109,999 barrels (15,400 tons) in quantity and of $94,451 in value, compared with 1914. The major production came as usual from 6½ miles west of Palestine, Anderson County, and from Grand Saline, Van Zandt County. Some solar salt was reported from Crane County and from Saltburg (Colorado post office), Mitchell County.

UTAH.

The production of salt in Utah in 1915 amounted to 394,850 barrels (55,279 tons), valued at $266,334, an increase of 19,393 barrels (2,715 tons) in quantity and of $34,822 in value, compared with 1914. The salt produced in Utah came chiefly from the shores of Great Salt Lake, at Garfield and Saltair, and from Salduro, Tooele County. Rock salt was produced in the Sevier Valley near Redmond, in Sevier and Sanpete counties. Though the salt is obtained in the form of rock salt and is sold in part as such, some of it is dissolved, recrystallized, and retailed in the refined form as table and dairy and packers' salt.

VIRGINIA.

Deposits of salt and gypsum occur in Washington and Smyth counties, Va., in a belt of country 20 miles long, running northeast from the village of Plasterco. The Saltville branch of the Norfolk &

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Western Railway, which joins the main line at Glade Spring, renders the region accessible. The rocks in which the deposits occur are of Mississippian age.

Two gypsum and one salt or alkali works are in operation in the region. Since 1895, when the Mathieson Alkali Works came into control of the property, the brine has been converted into soda products. Over 50 wells have been drilled near Saltville and Plasterco, about 25 of which are now in operation. They range in depth from a few hundred to 2,280 feet, the average depth being about 1,000 feet. The shallower wells are dry and have to be flushed with water through the outer casing. The deeper wells are wet, and brine flows into them as fast as it is pumped out.

WEST VIRGINIA.

The quantity of salt produced in West Virginia in 1915 was 232,239 barrels (32,513 tons), valued at $115,143, an increase of 86,810 barrels (12,153 tons) in quantity and of $37,107 in value. The salt was reported from Malden, Kanawha County, and from Mason and Hartford, Mason County. Bromine and calcium chloride are also made in connection with salt at these localities.

HAWAII.

One of the minor products of the Hawaiian Islands is salt, the output of which in 1915 was 2,400 tons, valued at $8 per ton. Most of the salt produced in the islands is the output of the Honolulu Salt Co., whose product is coarse salt made entirely by solar evaporation. The company operates at Puuloa, Kalihi, and Waikiki, on the island of Oahu, and at Mahukona, on the west coast of Hawaii.

PORTO RICO.

Both the quantity and the value of the salt produced in Porto Rico in 1915 were greater than in 1914. The salt is made by solar evaporation at Barrio de Boqueron, Cabo Rojo, and at Salina de Cabo Rojo, San Juan. Competing imports from Curaçao have tended to retard the production of salt in Porto Rico, because, it is said, both wages and living expenses are less in Curaçao than in Porto Rico.

BROMINE.

PRODUCTION.

Bromine is made in connection with the manufacture of salt at Mount Pleasant, Isabella County; Midland, Midland County, near Saginaw, and at St. Charles, Saginaw County, and Bay City, Bay County, Mich.; in the Ohio Valley at Pomeroy, Meigs County; at Mason and Hartford, Mason County, and in the Kanawha Valley at Malden, Kanawha County, W. Va. In Michigan the bromine has been marketed in the form of fine chemicals, but the great increase in demand, brought on by the war in Europe, has caused a great deal of the bromine to be marketed as such. Along Ohio River, where there is cheap transportation by rail and water and cheap coal and gas, and where salt and bromine occur naturally, bromine has been produced for export for many years to be made into fine chemicals.

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Here is an opportunity for the American chemist which should not be neglected.

Bromine marketed, 1880–1915.

Year.	Quantity (pounds)	Value.	Year.	Quantity (pounds)	Value.	Year.	Quantity (pounds)	Value.
1880	404,690	$114,752	1894	379,444	$102,450	1905	1,192,758	$178,914
1883	301,100	72,264	1895	517,421	134,343	1906	938,128	165,204
1884	281,100	67,464	1896	546,580	144,501	1907	1,000,827	195,281
1885	310,000	89,900	1897	487,149	129,094	1908	760,023	73,783
1886	428,334	141,350	1898	486,979	126,614	1909	569,725	57,600
1887	199,087	61,717	1899	433,004	108,251	1910	245,437	31,684
1888	307,386	95,290	1900	521,444	140,790	1911	651,541	110,902
1889	418,891	125,667	1901	552,043	154,572	1912	647,200	145,805
1890	387,847	104,719	1902	513,893	128,472	1913	572,400	115,436
1891	343,000	54,880	1903	598,500	167,580	1914	576,991	203,094
1892	379,480	64,502	1904	897,100	269,130	1915	855,857	856,307
1893	348,399	104,520						

The great increase in the output and especially in the value of bromine shown in the table for 1915 is significant. The price of bromine during the first five months of 1916 ranged from $4.75 to $6.50 per pound in New York, the result in part at least of the unprecedented demand from abroad, where it is said to be used in asphyxiating gases. The comparatively low price per pound indicated in the table is due to the fact that considerable bromine was sold at prices specified in contracts made before the demand increased and to the further fact that the figures indicate prices at the point of production, and hence do not include the cost of freight.

CALCIUM CHLORIDE.

PRODUCTION.

Calcium chloride is made from natural brines in the Saginaw Valley in Michigan, in the Ohio Valley in Ohio and West Virginia, and in the Kanawha Valley, W. Va. Thus practically every constituent in these brines is saved and turned into profit. Calcium chloride is manufactured at Mount Pleasant and Saginaw, Mich.; Pomeroy, Ohio; and Mason, Hartford, and Malden, W. Va.

Statistics of production of calcium chloride from natural brines have been collected by the Geological Survey since 1909. These figures given in the table below do not include the output obtained in the manufacture of soda, as such calcium chloride is not an original constituent of the brine. Large quantities of calcium chloride formerly wasted in the manufacture of soda, the source of which is different from that considered in this report, are now being used in part, and it is to be hoped that new uses for what is still wasted may soon be found.

Calcium chloride sold in the United States, 1910–1915.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	10,971	$74,713	1913	19,611	$130,030
1911	14,606	91,215	1914	19,403	121,766
1912	18,550	117,272	1915	20,535	130,830

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MICA.

By WALDEMAR T. SCHALLER.

CONDITION OF THE INDUSTRY.

High prices were paid for mica in 1915 as a result of the European war, and in consequence the mica industry was in a prosperous condition, as is clearly indicated by the table on page 284 showing the total production since 1880. The quantity of sheet mica, rough trimmed and cut, produced in 1915 was smaller than in any of the 12 preceding years, but the value is the highest recorded. The total value of all mica, sheet and scrap, produced in 1915 was $428,769, an amount exceeded only in 1913, when the value was $436,060. In no other year was the value so much as $400,000. The average price of sheet mica, rough trimmed and cut, was the highest in the last 13 years, as the following table shows:

Average price per pound of sheet mica, 1902–1915.

1903	$0.19	1908	$0.24	1913	$0.21
1904	.16	1909	.13	1914	.50
1905	.17	1910	.11	1915	.68
1906	.18	1911	.17		
1907	.33	1912	.33		

The statistics of production in 1915 refer only to mica that is used as such in the trade and that remains mica in its final application. The only mica thus included is muscovite. Phlogopite is extensively used in industrial work, but none is mined in the United States. Other micas were mined in 1915, notably roscoelite, which is similar to muscovite in composition, except that vanadium replaces some of the aluminum. Roscoelite is of value not because of its physical properties, but because it is used chemically as a source of vanadium; and it is therefore discussed in the chapter on vanadium in Mineral Resources. Lepidolite, a mica containing lithium and fluorine in larger proportion than most other micas, has in past years been utilized as a source of lithium salts; but in 1915 the output was all used in glass making. A bronze-colored material used for decoration is obtained by heating an altered hydrated biotite. Clinochlore, a micaceous mineral, a member of the chlorite family, is also used commercially, chiefly as a filling for hard-rubber goods. The production of lepidolite, biotite, and clinochlore is not included in the figures showing the output of mica but is given under the heading "Minerals allied to mica," on pages 289–290.

COMMERCIAL PROPERTIES OF MICA.

The chief physical properties that give value to mica are its cleavage, flexibility, elasticity, transparency, lack of color in thin sheets, nonconductivity of heat and electricity, and resistance to decomposi-

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tion. These properties make mica indispensable in the electrical trade, which consumes most of it. Only one producer reported a greater output of stove mica than of electrical mica. The output of electrical mica of the other producers shows percentages ranging from 76 to 100 of their total output of cut sheet mica. Cut stove mica brings a much higher price—from $1.50 to $3.33 a pound; the corresponding price for cut electrical mica is 9 cents to 74 cents a pound. Mica is sometimes called isinglass when it is used in glazing, but true isinglass, although resembling mica in some of its properties, is a gelatinous substance made of the air bladders of certain fish, is soluble in boiling water, and burns readily, whereas mica is not combustible.

The brilliancy of small scales of mica has made them valuable in the decorative arts, and hence ground mica is used extensively for the decoration of wall paper, to which it adds luster and brightness.

The crystals of mica are rough blocks, hexagonal if complete, or the mineral may occur in sheets of no regular shape, though perhaps one or two of the six sides of the crystal may be seen. The black, brown, or red inclusions of iron oxide—the "specks"—are in some crystals arrayed in straight lines, which are either parallel to or bisect the edges of the crystal.

The rough blocks or crystals of mica, as mined, must be freed from adhering rock and split into thin sheets, which are rough trimmed with a knife, and the mica is then graded for size and quality. The rough blocks, as obtained from the mines, yield only about 10 per cent of finished trimmed sheet mica ready for use in the electrical and glazing trades. The remainder is scrap mica, suitable only for grinding. A few crystals have been reported to yield as high as 80 per cent of trimmed sheets, but this yield is unusually large.

The average yield of cut sheet mica, ready for the trade, from run-of-mine mica, as deduced from the reports of the producers, is 17 per cent for New Hampshire, 10 per cent for South Dakota, and about 9 per cent for Virginia and for North Carolina. The average yield for the United States, as calculated from the reports of 15 producers, is about 11 per cent, the limits being 2 and 33 per cent, respectively; the average for the United States, as calculated from the total production, is 7 per cent. The Arizona State Bureau of Mines has published a bulletin[1] on mica in which is given a "flow sheet" from a New Hampshire mica mine, showing the quantities and values of mica in each 1,000 pounds mined used for different purposes. The yield of sheet mica, about 30 per cent, is much higher than the average for any single State.

The thin sheets of mica used in the trade are colorless. Muscovite in thin sheets is called clear or white mica; in sheets sufficiently thick to show a decided color, usually more than one-sixteenth of an inch, it is amber, yellow, green, brownish red or "rum," red or "ruby," smoky, gray, or brown. Phlogopite in thin sheets is generally yellowish or brownish; in thicker sheets it is yellow, brown, black, or coppery. Biotite is black and dark brown or green in thin sheets. "Specked" mica contains inclusions of dark minerals, mostly some form of iron oxide, which may be so abundant that the mica is called

[1] Cullin, F. L., jr., Mica: Arizona State Bur. Mines Bull. 16, Mineral Technology ser. No. 8, 1915–16.

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"black mica," even if the mica itself is nearly colorless. Although specked mica is inferior to clear mica for electrical insulation, it is satisfactory if used with discretion and in electrical apparatus in which the currents have only a low voltage. It has been used with satisfactory results where the currents measured less than 1,000 volts. The specks are extremely thin scales of iron oxide, which lie between the laminæ of the mica but do not penetrate the sheets and so do not greatly affect the insulating power of the mica. "Clay-stained" mica owes its unsightly appearance to the introduction of clay and dirt between the sheets. This clay may not penetrate the whole crystal or sheet and may be easily removed by splitting off the stained layer. Good mica should split to perfectly even, smooth sheets, but peculiar irregularities in crystal structure are rather common to all mica. Tangle-sheet mica will not split evenly, and ruled mica, to which the names ribbon, wedge, A, hair-lined, fish-bone, or herring-bone are applied, has but little value as sheet mica.

OCCURRENCE.

Mica is widespread in its occurrence and is one of the commonest minerals. It is found in many igneous rocks, in a large proportion of metamorphic rocks—as, for example, mica schist—and in many secondary rocks such as sandstone and shale. The natural processes of change which turn the feldspars of rocks into clay have but little effect on mica, which finds its way into the resulting sands and clays that are later consolidated into the sedimentary rocks—sandstones and shales. These bright, shining specks or scales of mica are often mistaken for gold or other valuable mineral, particularly if the original mica was biotite instead of muscovite, for much of the iron-bearing biotite assumes a golden-yellow or brownish color in its weathered forms.

The mica scales in the sandstones and shales are too small and too scarce to be of any commercial value. Many of the metamorphic rocks, such as the schists and gneisses, contain more mica than sandstone or shale, but the small size of the mica scales and the presence in abundance of quartz and other minerals has so far rendered such occurrences of doubtful value. Some mica schists or sericite schists (fine, shreddy muscovite is called sericite) that consist almost entirely of mica, with practically no quartz or other harder mineral, may be valuable. Quartz is so commonly associated with mica in metamorphic rocks that it seems doubtful whether any large bodies of sericite schist can be found that would be workable at a profit if mica should be the only product obtained. Sericite, as is noted by Rogers,[1] may be a low temperature modification of muscovite; it may be a dimorphous form and therefore a distinct species.

A small quantity of fresh pegmatite rock containing mica in scales larger than those of the metamorphic schists but still too small to be used otherwise than as scrap for grinding has been crushed and the mica extracted from it. Mica has also been concentrated from the residue of a clay plant that worked an altered pegmatite rock for its clay content, which was a product of decomposition of feldspar.

Mica forms about 4 per cent of all igneous rocks, but sheet muscovite can be extracted commercially only from pegmatite. Pegma-

[1] Rogers, A. F., Sericite, a low temperature hydrothermal mineral: Econ. Geology, vol. 11, p. 118, 1916.

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tite is a rock similar to granite in chemical and mineral composition, but has a more variable and coarser texture. It occurs in irregular-shaped masses, streaks, lenses, or sheets called veins or dikes, which vary many feet in both length and thickness. The surrounding rock is generally geologically very old, much of it changed to a gneiss or schist, the directions of whose structural features have had a large influence on the direction of the pegmatite sheet. In some mines the muscovite is concentrated in one or more well-defined layers or bands near the edges of the pegmatite, but more commonly it is scattered unevenly through the pegmatite, or the mica crystals may occur as individuals or in clusters scattered irregularly through the rock.

The occurrence of mica in sheets several feet in width makes it particularly valuable. Individual crystals 2 feet wide are not rare, and crystals 1 foot wide are common. A crystal from New Hampshire was 28 inches wide and 4 feet 2 inches long; another fine crystal was 2 feet wide and 2 feet long. Two crystals from North Carolina measured, respectively, 33 by 29 by 32½ inches and 33½ by 29½ by 17½ inches. Muscovite crystals 10 feet across the cleavage plane are reported to have been found in the Nellore district, India. Phlogopite has been reported from the Canadian mines in crystals 5 feet wide and nearly 10 feet long, weighing about a ton and a half. Mr. M. F. Westover, of the General Electric Co., states that one crystal measured 119 inches in width. It is of interest to record the gift of a section of a crystal of phlogopite from a mine near Sydenham, Ontario, Canada, to the United States National Museum, where the specimen is on public exhibition. The gift was made by Mr. Westover, through the United States Geological Survey. The section, which is somewhat less than an inch thick, measures 47 by 35 inches across the cleavage face. Crystals so large are very exceptional, few exceed 2 feet across the cleavage faces.

The United States, Canada, and India are large producers of mica, and it is also obtained from German East Africa, Brazil, South Africa, Ceylon, Norway, China, Japan, Argentina, and South Australia. Deposits that may be of value have been reported from several other countries.

Mica deposits of probable value have been found in about half the States of the United States. The principal producing States have been North Carolina, New Hampshire, South Dakota, Idaho, New Mexico, Colorado, Virginia, South Carolina, Alabama, and Georgia.

The possibility of the occurrence of mica deposits in the United States has been deduced by Sterrett[1] to be as follows:

> A study of the geologic map of North America shows the possibility of the occurrence of mica deposits in the following regions of the United States: In the eastern Appalachian region from Alabama to New York State and in the New England States; in northern Wisconsin, Michigan, and Minnesota, and in the region including corners of Minnesota and Iowa and part of South Dakota; in the Black Hills of South Dakota; in the Rocky Mountain region from New Mexico to Montana; and in many smaller more or less isolated areas in nearly all the Western States from Texas to California and Washington. The same map shows large areas in which younger sedimentary rocks cover the older crystalline rocks beneath a mantle ranging from hundreds to thousands of feet in thickness and in which, accordingly, mica deposits are not to be expected.

[1] Sterrett, D. B., Mica: U. S. Geol. Survey Mineral Resources, 1914, pt. 2, p. 68, 1915.

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USES.

The uses to which mica is put are very different and depend on its form—whether in sheets or in powder. Sheet mica is used in the electrical industry, for glazing, and to some extent for other purposes. Ground mica is used chiefly in the decorative trades and in insulating coverings.

Sheet mica finds its greatest use in the electrical industry, where an insulating, noninflammable material is necessary. It is used in sheets and as washers and disks in dynamo-electric machinery, electric-light sockets, spark plugs, insulators, guards in rheostats, fuse boxes, and telephones. Flexible cloth and tape, covered with mica, find varied uses in electrical apparatus. Sheet mica is used for glazing the fronts of stoves and for making lamp chimneys and lamp shades. It is also used in spectacles, automobile shields, phonograph diaphragms, and in windows where glass would be broken.

An apparently new use for mica sheets has been developed by George Palmer,[1] 47 Gerrard Street, London, W., primarily

for the use of cinematograph showmen, but of application also in any branch of lantern projection. Mica, as everybody knows, is a material which will withstand a certain degree of heat, although constant exposure to a fairly high temperature will lead to its disintegration in time. It is, however, easily scratched, a defect which Mr. Palmer has successfully overcome by a special process. Thus he is able to offer lantern transparencies which are not only unbreakable, but are fully capable of withstanding such damage in the way of scratching or exposure to heat as they are likely to get under the most trying conditions of arc projection and general handling. We have examined some of these slides and have found it impossible to scratch the surface short of using a sharp cutting instrument. The photographic image itself is one obtained by a firing process, and is therefore as permanent as the material which supports it. At present the slides are issued only in sepia—a fine rich sepia which projects excellently upon the screen. Each transparency is mounted in a metal frame which holds the mica flat, a set of such framed transparencies being very much less in weight than a corresponding set made in the usual way on glass with a cover plate of the same material. Mr. Palmer, however, supplies the special mica for such purposes as the making of cover plates for slides, so that those employing the ordinary glass lantern plates can secure considerable reduction in weight by substituting a mica for a glass cover plate without any disadvantage that we can see. For other photographic purposes a light transparent material with the physical properties of the prepared mica should frequently be of service.

Ground mica is used for decoration in wall paper, to which it gives luster and brightness; in fancy paints, ornamental tiles, concrete, rubber goods, pipe and boiler coverings, insulating compounds, fireproof paints and coverings, patent roofing material, molded mica (ground mica mixed with shellac), and calico printing; as absorbent for nitroglycerine in the manufacture of "mica powder," in tempering steel, and to a large extent as a lubricant for wooden bearings, or, mixed with oil, as a lubricant for metal bearings. Tar and other roofing papers are coated with coarsely ground mica to prevent sticking when they are rolled for shipment. A possible value of ground mica as a chemical source of potash salts is indicated in a recent report by B. S. Butler,[2] who lists a large number of analyses that represent the chemical composition of the tailings from copper ores, many of which are relatively high in potassium contained in muscovite.

[1] British Jour. Photography, vol. 63, No. 2928, p. 350, June 16, 1916.
[2] Butler, B. S., Potash in certain copper and gold ores, with a note on muscovite by George Steiger: U. S. Geol. Bull. 620, pp. 227–235, 1916.

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In the same publication Mr. Steiger[1] contributes a note on muscovite, from which the following is taken:

> Finely ground [and ignited] muscovite was intimately mixed with ammonium chloride in a mortar, and the material was then put into glass tubes, sealed, and heated to 350° C. in a bomb furnace. The tubes were next opened and their contents were leached with hot water and washed until the wash water gave no test for chlorine. * * * [The results indicated that practically all the potash] was found in the leach water, showing that by first fusing [igniting] the muscovite and then treating it with ammonium chloride its potassium was entirely converted into the soluble form. * * * More than 25 per cent of the potassium present may be converted into the soluble form by the treatment with ammonium chloride alone.
>
> Some experiments were also made to determine to what extent potassium might be extracted from muscovite by treatment with hydrochloric acid. The results stated below show that by a very superficial treatment with hydrochloric acid approximately one-third of the potassium may be extracted.

	Per cent K_2O.
Boiled 5 minutes with 1–1 HCl	3.36
Boiled 5 minutes with 1–10 HCl	2.94
Boiled 30 minutes with 1–1 HCl	4.24
Boiled 30 minutes with 1–50 HCl	3.21

Several trade names have been given to mica products that are briefly described below.

Micanite is a term applied by the Mica Insulator Co., Schenectady, N. Y., to a mica board made from many small, thin sheets of mica, which are fitted together and built up by successive layers that are cemented with shellac and then subjected to pressure under heat to dry out the shellac. Large sheets thus made are suitable for many electrical purposes.

Zilberglimmer, the German for silvery mica, is muscovite which has been heated to a sufficiently high temperature to make it softer and opaque and silvery in appearance. It is also known as annealed mica, and finds a use in certain parts of electrical apparatus.

Micarta is an artificial mica product developed by the Westinghouse Electric & Manufacturing Co., of Pittsburgh, Pa., and is intended to take the place of hard fiber, glass, porcelain, hard rubber, built-up mica board, rawhide, molded compounds for use in commutators, bushings, brush-holder insulation, noiseless gear blanks, conduits for wiring, spools for spark coil and magnet windings, wireless-coil separators, and water-meter disks. Micarta is a tan-colored, hard, homogeneous material that can be sawed, milled, turned, and threaded. Thin sheets can be punched, and it is claimed that it will not warp, expand, or shrink beyond very small limits. Two grades of micarta are made. One, known as bakelite micarta, is infusible and will resist heat to a point at which carbonization of some of the ingredients takes place. It is insoluble in nearly all ordinary solvents, such as alcohol, benzine, turpentine, and weak acid and alkali solutions.

Macamima, prepared by the Crawford Mica Co., of Crawford, Nebr., is a coarsely ground mica used in the manufacture of concrete facing material; mixed with other minerals it is used to give the effect of natural rock, and it may be used for different decorative purposes.

[1] Butler, B. S., Potash in certain copper and gold ores, with a note on muscovite by George Steiger: U. S. Geol. Survey Bull. 620, pp. 235–236, 1916.

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Micolith, prepared by the Texas Mica Co., of Pecos, Tex., is another similar product used to give the effects of natural rock to concrete facings.

Tungash, as the Denver Mining & Manufacturing Co., of Denver, Colo., call their product, is a bronze-colored, metallic-looking material of value for decoration. The crude biotite mica, altered and hydrated, has a dull greenish-black appearance when mixed. On being heated it expands to a light product, which has a rich golden-bronze color and a decidedly metallic luster. The production of this biotite mica has not been included in that of mica, but is given on pages 289–290 under the heading "Minerals allied to mica." The treatment by heat necessarily changes the chemical composition of the product, which is no longer that of the original biotite mica.

PRODUCTION.

The total value of the mica (muscovite) produced in 1915 was $428,769, the highest in any year since 1879 except 1913, when the value was $436,060. The value of the sheet mica produced in 1915 was the highest since 1879, but the production of all kinds of mica, or of either sheet or scrap mica alone, has been exceeded in several previous years. The production of all kinds of mica in 1915 (8,471,821 pounds) was exceeded by the production in 1909, 1910, 1911, and 1913, and was not much greater than that in 1907, 1912, or 1914. In fact the quantity of sheet mica produced (553,821 pounds) was the smallest since 1902. The fact that, with a relatively small production, a maximum value was recorded, shows that prices in 1915 were higher than in previous years.

The production came from 10 States—North Carolina, New Hampshire, Idaho, South Dakota, Virginia, Alabama, New York, Connecticut, Georgia, South Carolina—named in the order of the value of their output. New York reported no production in 1914, whereas Maryland and Maine, which produced mica in 1914, reported no production in 1915. New Mexico reported a little mica taken out but not sold, and Alaska reported several tons of scrap mica, also not sold. Colorado produced biotite mica and California produced lepidolite mica in 1915, but their production is put under the heading "Minerals allied to mica."

The percentage of production in the different States is shown in the following table:

Percentage of production of mica in 1915 by States.

State.	Sheet.		Scrap.	
	Quantity (pounds).	Value.	Quantity (tons).	Value.
North Carolina	51	70	72	67
New Hampshire	17	16	13	15
South Dakota	5	2	5	5
Virginia	2	2	2	2
Idaho				
Alabama				
New York	[a] 25	[a] 10	[a] 8	[a] 11
Connecticut				
Georgia				
South Carolina				
	100	100	100	100

[a] No single State except Idaho over 2 per cent.

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The total production of mica in North Carolina in 1915 was valued at $300,593, as compared with $195,270 in 1914. The production reported consisted of 281,074 pounds of sheet mica, valued at $266,650, and 2,840 tons of scrap mica, valued at $33,943. The production of sheet mica in 1914 amounted to 274,121 pounds, valued at $171,370, and of scrap mica to 1,789 tons, valued at $23,900. A large percentage of the mica from North Carolina is reported as cut mica, ready for the trade, and therefore is given a much higher value than the uncut or run-of-mine mica reported from other States.

The production in New Hampshire in 1915 was valued at $66,971, as compared with $47,837 in 1914. The production reported consisted of 96,685 pounds of sheet mica, valued at $59,414, and of 516 tons of scrap mica, valued at $7,557. The production of mica in 1914 amounted to 133,556 pounds of sheet mica, valued at $39,588, and of 600 tons of scrap mica, valued at $8,249.

Mica produced in the United States, 1880–1915.

Year.	Rough-trimmed and cut mica.		Scrap mica.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Short tons.*		
1880	81,669	$127,825	.....	.....	$127,825
1881	100,000	250,000	.....	.....	250,000
1882	100,000	250,000	.....	.....	250,000
1883	114,000	285,000	.....	.....	285,000
1884	147,410	368,525	.....	.....	368,525
1885	92,000	161,000	.....	.....	161,000
1886	40,000	70,000	1,000	$10,000	80,000
1887	70,000	142,250	2,000	15,000	157,250
1888	48,000	70,000	.....	.....	70,000
1889	49,500	50,000	196	2,450	52,450
1890	60,000	75,000	496	6,200	81,200
1891	75,000	100,000	.....	.....	100,000
1892	75,000	100,000	.....	.....	100,000
1893	51,111	80,629	156	8,300	88,929
1894	35,943	43,793	191	8,595	52,388
1895	84,408	50,381	148	5,450	55,831
1896	49,156	65,441	222	1,750	67,191
1897	82,676	80,774	740	14,452	95,226
1898	129,520	103,534	3,999	27,564	131,098
1899	108,570	70,587	1,505	30,878	101,465
1900	456,283	92,758	5,497	55,202	147,960
1901	360,060	98,859	2,171	19,719	118,578
1902	373,266	83,843	1,400	35,006	118,849
1903	619,600	118,088	1,659	25,040	143,128
1904	668,358	109,462	1,096	10,854	120,316
1905	924,875	160,732	1,126	17,856	178,588
1906	1,423,100	252,248	1,489	22,742	274,990
1907	1,060,182	349,311	3,025	42,800	392,111
1908	972,964	234,021	2,417	33,904	267,925
1909	1,809,582	234,482	4,090	46,047	280,529
1910	2,476,190	283,832	4,065	53,265	337,097
1911	1,887,201	310,254	3,512	45,550	355,804
1912	845,483	282,823	3,226	49,073	331,896
1913	1,700,677	353,517	5,322	82,543	436,060
1914	556,933	278,540	3,730	51,416	329,956
1915	553,821	378,259	3,959	50,510	428,769

This table has been compiled from the figures reported by the producers. The value therefore includes that of the cut mica ready for the trade, the uncut mica, and the run-of-mine mica. The run-of-mine mica is sold either in bulk at so much per ton or on contract at a fixed price per ton. The prices paid represent the value of the mica as it is taken from the mine and not the value of the finished cut mica ready for the trade. The finished cut mica brings a much

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higher price, as it is ready to be used in the industries and has had a considerable amount of money spent on it. It is obviously incorrect to add together the value of mica of two greatly different classes, yet this procedure is the only one that can at present be followed. The total production for the United States in 1915 of cut sheet mica was 273,684 pounds, valued at $275,367, an average price of $1.01 a pound. The total production of uncut sheet mica, which includes an estimated percentage of the sheet yield of run-of-mine mica, was 280,137 pounds, valued at $102,892, or an average price of only $0.37 a pound. Yet this uncut sheet mica needs only to be cut in order to have its value nearly trebled.

The figures so far given to show the production of mica in 1915 cover only muscovite sold. In addition, some mica was mined but not sold, the quantity and estimated value of which are given below. The sheet mica mined in 1915 but not sold amounted to 7,960 pounds—about 1 per cent of the sheet mica sold—and its estimated value was $4,080; the scrap mica mined but not sold amounted to 129 tons—about 3 per cent of the scrap mica sold—and had an estimated value of $1,837. The estimated value of all the mica mined but not sold is about 1 per cent of the value of all mica mined and sold.

Mica mined but not sold in 1915.

State.	Sheet.		Scrap.	
	Quantity (pounds).	Estimated value.	Quantity (short tons).	Estimated value.
Alabama	3,750	$2,748	2	$34
New Mexico	1,300	450	30	500
Georgia	1,500	270	12	190
Connecticut	300	189	1	12
New Hampshire	400	180	22	220
Virginia	535	168	45½	683
North Carolina	175	75	½	6
Alaska			9	108
South Carolina			7	84
	7,960	4,080	129	1,837

PRICES.

The first table in this report (p. 277) compares the average price per pound of sheet mica in 1915 ($0.68) with the smaller average prices in previous years. The higher prices prevailing in 1915 and holding in the first part of 1916 are due to unusual conditions, which result in part from the difficulties of importing mica. The report of the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, on the imports of mica for 1915 show, however, that in both quantity and value the imports of mica for 1915 exceeded those for 1914. As imports of mica are also being received in 1916, it is evident that the present high price of mica is somewhat artificial and that there is no guaranty of permanency. It may be an incentive for new development work, but it should be so taken with a good deal of caution.

The following table gives the average prices paid in the South for rough-trimmed mica of good quality sorted to cut the sizes indicated.

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Average prices per pound paid in the South for rough-trimmed mica of good quality.

Size (in inches).	1913	1914 (estimated).	1915, first half.	1915, second half.	1916, first half.
Punch	$0.035	$0.03	$0.04	$0.04	$0.05
1½ by 2	.12	.10	.12	.25	.25
2 by 2	.30	.25	.25	.50	.50
2 by 3	.70	.65	.60	.80	.85
3 by 3	1.15	1.00	.95	1.20	1.30
3 by 4	1.35	1.20	1.10	1.50	1.60
3 by 5	1.70	1.50	1.30	1.75	1.95
4 by 6	2.25	2.00	1.90	2.50	2.85
6 by 6	3.00	2.70	2.60	3.00	3.95
6 by 8	4.00	3.60	3.60	3.50	5.20
8 by 10	6.00	5.40	5.20	5.00	7.90

The table shows that the increase of prices in 1915, and even for the first half of 1916, is not very great, and that the greatest increase holds only for the smaller sizes. These prices are only averages; the actual price obtained by the miner depends so much on the condition and quality of his mica that great caution must be exercised in applying these prices to any lot of mica. The figures represent only those paid for good mica of the first and second quality. Mica of poorer grades is worth much less, as is shown by the following table, which gives the average prices, according to quality, paid in the South in the second half of 1915. As the table shows, size is the principal basis for grading rough-trimmed sheet mica after it is sorted for quality. The prices are those offered per pound for rough-trimmed mica, sorted to cut the sizes and qualities indicated.

Grades and prices per pound of mica, 1915.

Grade.	Size (in square inches).	Approximate corresponding sizes used as basis of purchase in the South.	Price according to quality.		
			No. 1 and No. 2 quality.	Spotted or slightly clay stained.	Black "specked," heavily clay stained.
Extra special	48 and up	8 by 10	$5.00	$4.00	$3.00
Special	36 to 48	6 by 8	3.50	3.00	2.50
1	24 to 36	6 by 6	3.00	2.50	2.00
2	14 to 24	4 by 6	2.50	2.00	1.70
		3 by 5	1.75	1.50	1.35
3	9 to 14	3 by 4	1.50	1.25	1.15
4	6 to 9	3 by 3	1.20	1.00	.95
		2 by 3	.80	.65	.45
5	3 to 6	2 by 2	.50	.30	.25
6	— to 3	1½ by 2	.25	.15	.....
		Punch [a]	.04	.04	.04

[a] Punch mica will yield disks 1½ inches in diameter.

A comparison of these prices with those for 1913 and 1914 shows that the greatest increase has been made in the prices of mica of the smaller sizes and that the increase in the value of clay-stained and black-specked mica has been greater than that in the value of mica of the first and second qualities.

The average price of sheet mica, including cut and uncut, in the United States in 1915, as deduced from the total production, was 68 cents a pound, as compared with 50 cents a pound in 1914 and 21 cents in 1913. The average price of sheet mica in North Carolina

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was 95 cents a pound, as compared with 63 cents a pound in 1914 and 29 cents in 1913; in New Hampshire the average price was 61 cents a pound, as compared with 30 cents a pound in 1914; in Idaho it was 25 cents a pound, as compared with 74 cents a pound in 1914; in Virginia it was 89 cents a pound, as compared with 81 cents a pound in 1914; in South Dakota, 32 cents, as compared with 5 cents a pound in 1914; in Alabama, 66 cents, as compared with 12 cents a pound in 1914. The variations in prices reported from different States in different years is largely due to the stage of manufacture in which the mica is reported. The mica sold in the rough at the mines necessarily includes a large proportion of scrap, and the prices are accordingly much lower than those for trimmed sheet mica reported by companies having trimming plants.

The average price of scrap mica in 1915, as deduced from the total production, was $12.76 a short ton, as compared with $13.78 a ton in 1914. In North Carolina the price was $11.95, as compared with $13.36 in 1914; in New Hampshire, $14.65, as compared with $13.74 in 1914; in Idaho, $16.99; in South Dakota, $15.05.

IMPORTS.

The imports for consumption of unmanufactured and trimmed sheet mica into the United States during 1915, as reported by the Bureau of Foreign and Domestic Commerce, Department of Commerce, were valued at $688,411, as compared with $625,396 in 1914. The reports show that 172 tons of ground mica, valued at $3,858, was imported in 1915, as compared with 202 tons, valued at $4,088, in 1914.

Unmanufactured mica imported into the United States, 1886–1897.

Year.	Value.	Year.	Value.
1886	$56,354	1892	$218,938
1887	49,085	1893	147,927
1888	57,541	1894	126,184
1889	97,351	1895	174,886
1890	207,375	1896	169,085
1891	95,242	1897	192,402

NOTE.—The imports in 1886–1890, inclusive, comprise waste or scrap mica.

Mica imported into the United States, 1898–1915.

Year.	Unmanufactured.		Cut or trimmed.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
1898	877,930	$115,930	78,567	$34,152	.....	.....	956,497	$150,082
1899	1,709,839	233,446	67,293	42,538	.....	.....	1,777,132	275,984
1900	1,892,000	290,872	64,391	28,688	.....	.....	1,956,391	319,560
1901	1,598,722	299,065	78,843	35,989	.....	.....	1,677,565	335,054
1902	2,149,557	419,362	102,299	46,970	.....	.....	2,251,856	466,332
1903	1,355,375	288,783	67,680	29,186	.....	.....	1,423,055	317,969
1904	1,085,343	241,051	61,986	22,663	.....	.....	1,147,329	263,714
1905	1,506,382	352,475	88,188	51,281	.....	.....	1,594,570	403,756
1906	2,984,719	983,981	82,019	58,627	.....	.....	3,066,738	1,042,608
1907	2,226,460	848,098	112,230	77,161	.....	.....	2,338,690	925,259
1908	497,332	224,456	51,041	41,602	.....	.....	548,373	266,058
1909	1,678,482	533,218	168,169	85,595	.....	.....	1,846,651	618,813
1910	1,424,618	460,694	536,905	263,831	(a)	$1,298	1,961,523	725,823
1911	1,087,644	346,477	241,124	155,686	(a)	3,389	(a)	505,552
1912	1,900,500	649,236	88,632	99,737	b 343,824	b 6,611	2,332,956	755,584
1913	2,047,571	751,092	(a)	191,926	290,757	4,765	(a)	947,783
1914	360,888	168,591	(a)	456,805	404,848	4,088	(a)	629,484
1915	433,822	240,449	(a)	447,962	344,040	3,858	(a)	692,269

a Quantity not reported.

b Figures cover only last six months of 1912.

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The average value of imported unmanufactured sheet mica, per pound, as calculated from the figures for 1915, was 47 cents, as compared with the average value of 37 cents for uncut sheet mica produced in the United States in 1915.

EXPORTS.

The exports of mica, chiefly to Canada, France, England, Belgium, and Germany, as reported, are as follows:

Mica exported from the United States, 1910–1915.

Year.	Unmanufactured.		Manufactured.	Total value.
	Quantity (pounds).	Value.	Value.	
1910				$20,543
1911	415,862	$15,649	$20,267	35,916
1912	356,601	14,936	25,876	40,812
1913	298,711	14,175	48,009	62,184
1914	467,451	23,145	27,751	50,896
1915	54,183	5,118	33,915	39,033

FOREIGN MICA.

CANADA.

The preliminary report on the mineral production of Canada gives the value of the mica produced in Canada in 1915 as $81,021. The manufactured mica exported to the United States, a total of 879,631 pounds, was valued at $236,124.

Consul F. S. S. Johnson,[1] of Kingston, Ontario, reports that—

> The price of fine-split amber mica, size 1 by 2, at present exported largely from the Ottawa district, and invoiced at from 20 to 35 cents per pound, is very low when the following facts are taken into consideration: Market value per pound of rough amber mica, 1 by 2, 12 cents; price paid for splitting 1 pound of amber mica, 12 cents; waste on 1 pound of fine amber mica, 4 cents; freight and handling from mine to factory, one-half cent; profit, 8 cents; total, 36½ cents.
>
> Most of the Ontario mica is mined in this consular district and taken to Ottawa to be trimmed and prepared for the American market. The fine-split amber mica is invoiced at this consulate at from 33 to 38 cents per pound.

BRAZIL.

Mica occurs in Brazil in workable quantities in the States of Goyaz, Bahia, and Minas Geraes, according to A. F. Calvert.[2] Although of good quality, the mica produced from Goyaz and Bahia is small in quantity, and little is known of its occurrence. The principal producing mines are pegmatite veins, lenses, or dikes, which occur in the metamorphic schists near the city of Santa Luzia de Carangola, on the borders of the States of Minas Geraes and Espirito Santo. The rocks are greatly decomposed and the pegmatite veins, from 20 inches to 10 feet wide, are largely composed of kaolin, in which the mica crystals are irregularly disseminated.

[1] Commerce Reports, Sept. 18, 1915.
[2] Calvert, A. F., Mineral resources of Minas Geraes (Brazil), p. 92, 1915.

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CHOSEN (KOREA).

The mica mines of Chosen (Korea) have been described by Shigetaro Kawasaki.[1] Both muscovite and phlogopite occur and have been known and used by the people of Chosen (Korea) for a long time. In 1909 mining for mica in Chosen (Korea) was undertaken by the Japanese. No figures of production or value are given in the English text.

CHINA.

Mica that seems to be of very good quality is reported by Consul E. C. Baker, of Chungking, China, to be found near Sungpan, in the Szechwan Province, West China, and one of the large Chinese firms there, which has a branch office in Shanghai, is prepared to export this product. The price, delivered at Shanghai, is between 9 and 10 cents United States currency per pound. About 15,000 pounds can be delivered every year.

INDIA.

The production of mica in India in 1914, the last year for which figures are available, is reported by Consul L. Memminger in the Commerce Reports to be 38,189 hundredweight. The production for 1913 is reported[2] as 45,422 hundredweight, as compared with 43,835 hundredweight in 1912. The value of the exports in 1913 amounted to £347,451 ($1,690,870), as compared with £284,290 ($1,383,497) in 1912.

The condition of the trade was fairly good during the first half of 1914, according to the report of the Chief Inspector of Mines in India for 1914, prices being slightly lower than in 1913, which was an exceptionally good year. The trade suffered severely from the beginning of the European war, and the output fell away in consequence. A large proportion of the demand for this mineral has hitherto come from Germany for use in its electrical industries. Certain firms with German interests, which were large purchasers of mica, have, it is stated, closed down. The export of mica to other countries in Europe was practically cut off, and the industry generally was much hampered by the abnormally high rates for ocean freights and insurance, brought about by the war. There was considerable difficulty with regard to shipments to America—to which country considerable consignments are sent direct in normal times—and the American market itself was dull. It is further reported that 4 mica mines in the Nellore district in Madras were relinquished and 40 were suspended, and the output during the last five months of the year (1914) was only 700 hundredweight, as compared with 4,700 hundredweight in the first seven months. The demand from London for slab mica kept the prices of this grade fairly firm, but the market for splittings, especially for those below the first grade, was much reduced.

MINERALS ALLIED TO MICA.

The minerals included under the heading "Minerals allied to mica" are as follows: (1) Biotite from Colorado, described in the earlier part of this report under "Tungash" and mined by the Denver

[1] Mica in Chosen: Chosen (Korea) Mineral Survey Bull., vol. 1, pt. 2, Seoul, 1916.
[2] India Geol. Survey Records, vol. 46, p. 180, 1915.

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Mining & Manufacturing Co., of Denver, Colo., which has been heated before being put on the market and thereby has its chemical character as a mica destroyed by partial loss of water and possibly other volatile constituents and by change in state of oxidation of the iron. The finished product is still micaceous in structure, but the new color and luster, acquired by the calcination, are probably of more value to the finished product than its micaceous structure. (2) Lepidolite from California, mined by the American Lithia & Chemical Co., 50 Church Street, New York, N. Y., which in former years has been utilized as a source of lithium salts, but which in 1915 was mined for use in making glass. (3) Clinochlore or chlorite schist, mined by the American Mica Co., 52 Broadway, New York, N. Y., at Canton, Ga., whose product ground to various meshes is used chiefly in composition of hard rubber and to a less extent in the manufacture of rubber tires, and of ready roofing, foundry facing, and lubricants.

The combined production of these three "allied minerals"—biotite, lepidolite, and chlorite schist—only the material actually sold being included for 1915, was 423 tons, valued at $7,685. In addition, there was mined but not sold a total of 1,020 tons having an estimated value of $19,410.

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SULPHUR, PYRITE, AND SULPHURIC ACID.

By W. C. PHALEN.[1]

SULPHUR.

THE DOMESTIC SULPHUR INDUSTRY.

Sulphur was produced in 1915 in Louisiana, Texas, Nevada, and Wyoming. The production in the two Western States was small, amounting to only slightly more than 1 per cent of the total output of the country. Thus more than 98 per cent came from the Union Sulphur Co., in Louisiana, and the Freeport Sulphur Co., in Texas. To avoid revealing confidential reports of output of these companies the figures for sulphur will not be tabulated, as they have heretofore been. They will be published in the table of mineral production of the United States and in the totals for the two States named, lumped, however, with other commodities, so that the value as sulphur will not be shown.

Though 1915 was a prosperous year in the sulphur industry, the output was not so great as in 1914. During the early part of the year business was somewhat dull, but it improved gradually as the year advanced. Slack conditions in the paper trade account in part for the falling off. The export trade in sulphur, as will be noted from a later statement in this report, was the lowest in some years, in spite of the partial paralysis of the sulphur trade in Italy incidental to the war in Europe. European inquiries for American sulphur have come from as far away as Greece.

Though the imports of foreign pyrite were not so great in 1915 as in 1914, they amounted to 964,634 long tons. In spite of these large imports and of a domestic output of pyrite of 394,124 long tons (an increase as compared with 1914), there has been, especially late in 1915 and early in 1916, an increasing call for sulphur from which to make sulphuric acid, owing to the great expansion in certain branches of chemical industry, and to the fear that in some way foreign shipments of pyrite might be curtailed. The high price received for the acid has made the use of the comparatively high-priced sulphur possible, but the use of sulphur has also certain obvious advantages owing to its purity and to the consequent fact that it leaves little or no residue. It is possible that in the manufacture of the highest grades of acid sulphur will continue to be used.

[1] The statistics in this report were prepared by Miss H. M. Gaylord.

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The stocks of sulphur on hand at the close of 1915 were the largest in the history of the industry.

IMPORTS.

The first table given below includes the usual classes of sulphur, together with grades not specifically defined. The second table shows that practically all our imports of sulphur in recent years have come from Japan and were entered at Pacific coast or Hawaiian ports.

Sulphur imported and entered for consumption in the United States, 1912–1915, by kinds.

Year.	Crude.		Flowers of sulphur.		Refined.		All other.[a]		Total.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1912	26,885	$494,778	1,311	$39,126	1,665	$40,933	66	$9,137	29,927	$583,974
1913	15,122	286,209	5,899	115,574	1,234	29,091	350	17,690	22,605	448,564
1914	23,610	398,984	621	17,214	1,300	47,568	104	14,171	26,135	477,937
1915	24,647	405,990	647	23,146	988	30,335	85	12,987	25,910	472,458

[a] Includes sulphur lac and other grades not otherwise provided for, but not pyrite.

Crude sulphur or brimstone imported into the United States, 1912–1915, by countries and by customs districts.

Countries whence exported and customs districts through which imported.	1912		1913		1914		1915	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
COUNTRY.								
Canada	.....	.....	98	$2,372	.....	.....	90	$2,000
United Kingdom	.....	.....	101	2,905	123	$3,312	1	23
Italy	2,348	$46,003	125	3,046	747	19,691	23	699
Japan	24,505	447,946	14,317	269,730	21,913	385,498	24,533	403,268
Other countries	32	829	.....	3	27	1,036	.....	.....
	26,885	494,778	14,641	278,056	22,810	409,537	24,647	405,990
CUSTOMS DISTRICT.								
Baltimore, Md.	.....	.....	.....	.....	.....	.....	.....	.....
Boston and Charlestown, Mass.	.....	.....	15	343	.....	.....	.....	.....
New York, N. Y.	1,359	29,387	140	3,809	185	5,216	.....	.....
Los Angeles, Cal.	850	13,757	1	42	1,320	26,493	750	12,171
San Francisco, Cal.	15,984	280,010	5,110	86,146	12,460	218,842	11,862	186,743
Willamette and Portland, Oreg.	7,646	149,612	6,802	128,709	7,164	124,907	7,287	119,534
Hawaii	1,000	20,916	523	8,923	1,182	22,669	960	17,529
All other	46	1,096	2,050	50,084	499	11,410	3,788	70,013
	26,885	494,778	14,641	278,056	22,810	409,537	24,647	405,990

EXPORTS.

In 1913 the United States exported 89,221 long tons of sulphur, valued at $1,599,761. In 1914 the exports were 98,163 long tons, valued at $1,807,324. In 1915 they declined greatly and were only 37,312 long tons, valued at $724,679. Adverse conditions in Europe and in the carrying trade are largely responsible for this slump, but

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the balance of trade in favor of the United States as between imports and exports of sulphur was 11,402 tons in quantity and $252,221 in value.

THE SULPHUR INDUSTRY IN TEXAS.

FREEPORT SULPHUR MINES.

The process of mining sulphur at Bryan Heights, near Freeport, Brazoria County, Tex., has been fully described in previous volumes of Mineral Resources. Since 1914 only such changes have been made as experience has suggested.

During 1915 systematic prospecting has been carried on. Drilling rigs have been continuously at work boring through the sulphur formation at regular intervals and testing the richness of the sulphur-bearing stratum at different points. Operating wells are located in the light of the information thus obtained.

The production of sulphur in 1915 was much larger than in 1914. The rapidity with which the product is being absorbed in the world's market and the satisfactory disclosures of the prospecting have influenced the Freeport Sulphur Co. again to increase greatly the capacity of the plant. Plants Nos. 1 and 2 adjoin and are on the south slope of the "Mound," as Bryan Heights is locally known. They have a combined capacity of 7,000 rated horsepower, operated under approximately 50 per cent overload, making over 10,000 developed horsepower.

Plant No. 3 is located about 3,500 feet nearly due north of the older plants and on the north slope of the Mound. It is being equipped with twelve 700 horsepower boilers, which have a total of 8,400 horsepower. This additional power more than doubles the combined capacity of the existing plants and gives a total for all plants of 15,400 rated horsepower, developing practically to 23,000 horsepower. The machinery equipment in the new plant will consist of 8 high-pressure heaters, 32 mine-water pumps (16 high pressure and 16 low pressure), 2 exhaust mine-water heaters, 2 high-pressure air compressors to furnish air for pumping liquefied sulphur from the wells, and 1 compressor for pumping boiler water from driven wells.

The plant will be housed in buildings of fireproof construction, nothing but concrete and steel being used. The stack will be of concrete, 157 feet high with a 16-foot inside diameter at the base. Independent reservoirs are being constructed to hold water for the new plant, divided as to boiler and mine waters, with a capacity of 50,000,000 gallons. These reservoirs will be connected with the existing reservoirs, making them mutually interdependent and able to transfer water in case of need from one to the other. Additional driven wells will provide water for the boiler supply, but the enormous quantity of water required for mine operations will come from the 3½-mile canal already constructed, which brings the water of Brazos River to the pumping station serving the reservoirs. Concrete flumes of large size will connect the reservoirs with the plant, through which the water will be brought to the suction of the pumps located within the plant. Additional electrically driven centrifugal pumps of great capacity will transfer the water from canals to reser-

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voirs. The total quantity of water required for all plants is approximately 7,000,000 gallons daily, all of which must be softened to prevent formation of scale. A lime treating plant for this purpose will be constructed so that the water going to the boilers and heaters will be practically free from scale-forming constituents. An elevated steel tower, with tank, is now being constructed to supply under heavy pressure the general requirements for water independently of those of the plant.

A second turbo-generator will furnish electric current for additional power and for light.

The consumption of fuel oil in all the plants will be approximately 3,500 barrels daily. Oil tank steamers will deliver this oil directly into large storage tanks located on the harbor front, from which it will be pumped to the mines. The transfer of the oil will be through an 8-inch pipe-line, 4½ miles in length. The fuel will be stored in two large steel oil tanks and a reserve adequate to cover a considerable period of operations will be kept. The wooden oil-storage tanks heretofore serving the older plants are being replaced by steel storage tanks of capacity equal to those provided for the new plant.

At least four sulphur wells may be pumped simultaneously in the combined plants, and the production from the Freeport sulphur mines, which are already taking a prominent place in supplying the world's sulphur requirements, should at least be doubled.

A narrow-gage railway, with motor cars and trucks, will connect the two plants, bringing machine shop, storeroom, and other adjuncts into prompt communication.

The shipping facilities are being increased, and new railroad tracks are being built to plants and bins. A most important part of this work is the construction, now well under way, of new docks on the harbor, from which steamers will be loaded on the western or mine side of the Brazos channel. Freeport Harbor is being developed in the lower reaches of the river near the head of the jetties, which extend well out into the Gulf of Mexico. The channel opposite the new docks will be dredged to the proper depth. In loading vessels, heretofore, it has been necessary to cross the river on the railroad ferry. A conveyor has been used at the old docks to elevate the sulphur after dumping from cars and to deliver it at the rate of about 80 tons an hour to the head of the chute through which it passed into the holds of the vessels. The new docks will be so constructed that bottom-dump cars will pass up on an elevated structure and will empty into a continuous hopper, with chutes leading at frequent intervals to the hatches of the loading vessel. The delivery will be accomplished by gravity, thus greatly increasing efficiency and lowering the loading cost. A complete equipment of steel bottom-dump hopper cars, each of 50-ton capacity, has been purchased. A railroad extension has been completed to serve these docks, which provides a short haul direct from the mines.

The mines are in a peculiarly favorable location by reason of the fact that they are practically at tidewater. The advantages of location in distributing the product and receiving raw material are obvious. Vessels load sulphur at point of production, and there are rail connections to important southern railway systems.

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FOREIGN SULPHUR DEPOSITS.

SICILY.

According to United States Consul J. E. Haven[1] the production of sulphur in Sicily in 1914 was 334,974 metric tons, 11,000 tons less than in 1914. The production has been declining for several years, owing to the lack of capital; to the shutting down of some of the large mines on account of fires; to competition from the United States, now the principal sulphur-producing country; to the increasing use of pyrite as a source of sulphur; and, finally, in the last two years, to a partial paralysis of the sulphur trade by reason of the war in Europe.

Sulphur shipped by producers in Sicily, 1913–14, in metric tons.

Destination.	From Catania.		Total from Sicily.	
	1913	1914	1913	1914
Sicily	2,529	1,756	8,504	7,604
Italy	32,368	34,891	72,971	89,611
Austria-Hungary	7,455	7,942	36,334	25,304
Belgium	2,053	939	13,321	5,977
Denmark	305	239	305	239
France	114	216	75,186	61,871
Germany	13,422	8,095	31,968	18,824
Greece	13,505	10,964	14,615	15,759
England and Malta	8,992	9,725	16,036	12,998
Netherlands	7,857	6,835	8,975	8,080
Portugal	5,238	1,336	14,754	8,427
Russia	4,156	3,201	25,892	21,289
Spain	4,327	1,915	6,684	9,178
Sweden and Norway	6,700	5,684	27,804	23,877
Turkey in Europe	1,904	1,177	1,911	1,177
United States and Canada	1,383	1,919	1,383	1,919
Central and South America	4,313	944	7,340	944
Egypt	615	1,260	615	1,260
Algeria and Tunis	2,134	462	3,242	2,226
Asiatic Turkey	3,590	3,738	3,596	3,914
British India	5,736	4,316	5,736	4,316
Australia	2,068	62	13,441	1,637
South Africa	1,243	426	13,741	2,486
Other countries	6,756	6,298	10,362	9,396
	138,763	114,340	414,716	338,308

Sulphur produced and shipped in Sicily during the year, and stock on hand Dec. 31, 1908–1914, in metric tons.

Year.	Production.	Shipments.	Stock on hand.	Year.	Production.	Shipments.	Stock on hand.
1908	404,297	375,073	616,419	1912	357,547	447,292	450,917
1909	402,353	364,513	647,880	1913	345,974	414,716	376,356
1910	397,808	393,987	640,711	1914	334,974	338,308	369,001
1911	376,171	453,826	551,422				

The increased cost of the extraction of the ore at the mines induced the producers to petition the Government syndicate that controls the sale of the sulphur (Consorzio obbligatorio per l' industria solfifera siciliana) to advance prices, which request was granted in July, 1914.

[1] Supplement to Commerce Repts., Aug. 18, 1915, pp. 7–9.

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The Consorzio's prices of crude sulphur in bulk on board lighters at the port of Girgenti, Sicily, 1914, are given in the following table:

Government prices of sulphur in Sicily, 1914.

Quality.	Purity.	Price per ton.		Quality.	Purity.	Price per ton.	
		Jan.–July.	Aug.–Dec.			Jan.–July.	Aug.–Dec.
	Per cent.				*Per cent.*		
Yellow superior.....	99	$19.30	$19.78	Brown superior.....	96	$18.72	$19.20
Yellow inferior.....	97	19.11	19.59	Brown inferior.....	95	18.53	19.01

Crude sulphur in bulk is seldom shipped from Catania. The Consorzio conveys it here for refining and milling and supplies only enough to fill the demand, and in order to discourage its export in the natural state from this port the syndicate has established a higher price from Catania than from Girgenti.

Refined and milled sulphurs, which are chiefly exported from Catania, were in fairly active demand during the year. Local competition is keen and profits small. Owing to the increased cost of refining, increased prices of bagging, and cost of wood for the casks, prices for the sulphurs have advanced.

The market prices of refined and milled sulphur at the end of 1914 per metric ton f. o. b. Catania (in 112-pound sacks), were as follows: Sublimed flowers of sulphur, $34.35; refined sulphur in rolls, $27.98; refined sulphur in lumps, $28.79; and refined ground sulphur, $25.09.

JAPAN.

According to Consul General G. H. Scidmore[1] the exportation of sulphur from Japan has been on the decline for some years and some of the smaller mines have had to shut down. Since the outbreak of the war in Europe, however, foreign demand has improved and quotations have gradually increased. The exports up to the end of August, 1915, were 13,974 short tons, valued at $203,048, an increase of 2,319 tons in quantity and of $20,003 in value, compared with the corresponding period of 1914.

The bulk of Japanese sulphur has been shipped to the United States and Australia and to a less extent to Canada and India. Only an insignificant quantity has gone to Europe. Since the war, however, the export of European sulphur to the Orient has almost ceased and the demand in Europe has increased. Therefore, the demand for Japanese sulphur has increased in the Orient, in America, and also in Europe, and the outlook for the Japanese sulphur industry appears promising.

DESULPHURIZING PROCESSES.

William A. Hall[2] has patented a process for the production of sulphur from pyrite or metallic sulphides in general. It has been

[1] Japanese Advertiser, Sept. 23, 1915.

[2] United States patent 1133636, dated Mar. 30, 1915.

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assumed that in pyrite there is one feeble and one fixed atom of sulphur and that the feeble atom can be removed by distillation whereas the fixed atom can not. Hall has found that under certain conditions of distillation both atoms of sulphur in pyrite act alike and that both can be removed by distillation without prior conversion into sulphur dioxide and hydrogen sulphide and the mutual reaction of these gases.

To bring about the reaction, there is applied to the pyrite a non-oxidizing flame, or preferably the reducing flame from a gas or gas mixture high in hydrogen. The hydrogen in the flame burns to water, which at the high temperature of the interior of the furnace is decomposed into hydrogen and oxygen on contact with the hot pyrite, thus liberating sulphur. The nascent oxygen forms oxide of iron by combining with the iron in the pyrite and the hydrogen again burns to water, or it may combine with some of the sulphur to form hydrogen sulphide. The sulphur which is liberated by the reactions is drawn off. Some sulphur may also be produced by the action of sulphur dioxide and reducing gases like carbon monoxide.

Fine ore is preferably used and a temperature of 700° to 900° C. is maintained in the several compartments of the furnace. Under such conditions sulphur distils very rapidly from the ore.

William A. Hall[1] has invented what is claimed to be improvements in processes of preventing the escape of noxious gases like sulphur dioxide (SO_2) in smelting. The object of the invention is to convert the sulphur dioxide, produced in the focus of the blast furnace, into the harmless material sulphur before it reaches the air. This object is attained preferably by the formation of a reducing agent within the furnace structure at a point well above the focus but where the temperature is still high enough to produce the reducing agent and to bring about the reaction between it and the sulphur dioxide.

The top of the ore body is kept as cool as possible by adding new ore and by continuously spraying with water. By this means ignition of the sulphur vapor is prevented, even in the presence of considerable oxygen. Part of the water percolates downward through the body of the ore, keeping it cooler than in the ordinary smelting process. The water as it is carried downward forms steam which, reacting with the ore, forms hydrogen sulphide. This hydrogen sulphide reacts with the sulphur dioxide present in the gases and forms elementary sulphur ($2H_2S+SO_2=2H_2O+3S$). The sulphur thus formed is carried out as vapor.

In this manner substantially all of the sulphur dioxide produced in the smelter may be decomposed, and the gases and vapors, together with flue dust, leaving the smelter may be passed through a dust-settling chamber of the ordinary construction and the sulphur in solid form recovered, thereby producing a by-product of considerable value.

William A. Hall[2] has described a process to recover sulphur in commercial form from the vapors and gases discharged in smelting operations. A reducing flame is admitted, preferably with steam, into the upper level of the furnace. This prevents the elementary sulphur vapor passing upward in the furnace from being oxidized and it also reduces the sulphur dioxide present to sulphur. The high

[1] United States patent 1133637, dated Mar. 30, 1915.
[2] United States Patent 1134846, dated Apr. 6, 1915.

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temperature produced by this reducing flame is necessary because the sulphur dioxide can not be reduced except at very much higher temperatures than normally exist in the upper portion of the furnace. The reducing flame may be produced by burning water gas or air and water gas from a gas producer containing much carbon monoxide and hydrogen.

In this process the separation of the bulk of the sulphur from the pyrite or other ore and its volatilization are not effected by the reducing flame but primarily by the temperature imparted to the ore charge by combustion in the fusion zone.

The temperature preferred at the top of the ore charge may be 700° C. or a little higher.

W. F. Lamoreaux and C. W. Renwick[1] have invented an improved process for recovering sulphur from gases from roasting, smelting, or calcining furnaces. When such gases are passed through an incandescent layer or body of coke or similar carbonaceous material, sulphur dioxide, for example, is decomposed and sulphur is liberated, as indicated by the following reactions:

$$SO_2+C=CO_2+S;\ SO_2+2CO=2CO_2+S$$

As a specific example: In passing sulphur dioxide from pyrite furnace gases over a bed of coke heated to the required degree by passing an electric current through it, it was determined that when the gas and coke were in contact five seconds 5 per cent of the gas was reduced at a temperature of 800° C. and increasing quantities of the gas up to 1,300° C., when 98 per cent of it was reduced.

Within the limits mentioned, the higher the temperature maintained the more rapid will be the formation of the sulphur. Also, the amount of sulphur formed is found to increase in proportion to the length of time during which the gases are in contact with the incandescent carbon. In other words, either an increase in the depth of the incandescent mass of carbon through which the gases pass or a decrease in the velocity of the gases in passing through such an incandescent mass of carbon will result in a greater percentage of sulphur formed.

PYRITE.

PRODUCTION.

The domestic production of pyrite in 1915 attained a new high level, due chiefly to the unprecedented demand for the ore in making sulphuric acid. The production was 394,124 long tons, valued at $1,674,933, an increase of 57,462 tons in quantity and of $391,587 in value, compared with 1914. The consumption of ore—that is, the combined domestic production (394,124 tons) and imports (964,634 tons)—was 1,358,758, a decrease of 4,521 tons, compared with 1914. This was caused by the falling off in imports. The general resumption of activity at acid plants especially created a great demand for both foreign and domestic pyrite, and the imports, particularly of European pyrite, would have been larger if suitable vessels had been available for the carrying trade.

[1] United States patent 1140310, dated May 18, 1915.

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Pyrite marketed in the United States, 1913–1915.

State.	1913			1914			1915		
	Quantity (long tons).	Value.	Average price per ton.	Quantity (long tons).	Value.	Average price per ton.	Quantity (long tons).	Value.	Average price per ton.
California	70,536	$218,525	$3.10	71,272	$235,129	$3.30	132,270	$496,111	$3.75
Georgia	11,110	55,094	4.96	(a)	(a)	(a)	(a)	(a)	(a)
Illinois	11,246	31,966	2.84	22,538	59,079	2.62	14,849	22,476	1.51
Indiana	1,242	3,115	2.51	1,710	5,281	3.09	972	3,080	3.17
Ohio	13,622	34,998	2.57	7,279	19,718	2.71	10,857	27,404	2.52
Virginia	148,259	587,041	3.96	141,276	556,091	3.94	145,050	729,644	5.03
Wisconsin	25,328	94,727	3.74	14,188	78,460	5.53	13,985	43,354	3.10
Other States[b]	59,995	260,618	4.34	78,399	329,588	4.20	76,141	352,864	4.63
	341,338	1,286,084	3.77	336,662	1,283,346	3.81	394,124	1,674,933	4.25

[a] Included in "Other States."
[b] 1913: Missouri and New York; 1914: Georgia, Missouri, and New York: 1915: Georgia, Missouri, New York, Pennsylvania, and South Carolina.

The historical table showing the production of pyrite in the United States since 1882 was published in this report for 1914 and is therefore omitted. For the benefit of students and others who are interested in the pyrite industry this table will be incorporated at intervals in future reports.

IMPORTS.

Imports for consumption of pyrite containing not more than 3.5 per cent of copper, 1911–1915.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1911	1,006,310	$3,788,803	1914	1,026,617	$4,797,326
1912	970,785	3,841,683	1915	964,634	4,817,977
1913	850,592	3,611,137			

WORLD'S PRODUCTION OF PYRITE.

In the following table is given the world's production of pyrite and the quantity of pure sulphur which it is supposed to replace in the market, estimated on the assumption that the pyrite averages 45 per cent in sulphur.

Wherever possible the figures are taken from the official publication of the country concerned, which is the case with Canada, Belgium, France (in part), the German Empire (in part), and Italy; otherwise, the British Blue Book, known as Mines and Quarries, London, has been used except for 1913, when figures for all countries except Canada, Italy, and the United Kingdom are from Mineral Industry. The rapid increase in the production of pyrite in Canada is worthy of note.

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Iron pyrite produced in principal producing countries and sulphur displaced, 1910–1915, in long tons.

Country.	1910	1911	1912	1913	1914	1915
North America:						
Canada	48,098	73,809	72,791	141,577	203,852	265,098
United States	241,612	301,458	350,928	341,338	336,662	394,124
Europe:						
Belgium	211	120	146	264	(a)	(a)
Bosnia and Herzegovina	56	3,069	6,118	7,580	(a)	(a)
France	246,488	273,565	277,758	306,267	(a)	(a)
German Empire	212,311	214,034	258,517	[b] 224,808	(a)	(a)
Greece	32,767	35,390	29,294	126,838	127,014	(a)
Hungary	91,008	95,231	102,174	104,950	(a)	(a)
Italy	133,492	143,823	244,697	287,477	330,247	(a)
Norway	[c] 324,457	[c] 363,243	[c] 457,014	[c] 434,342	(a)	(a)
Portugal	289,119	[d] 272,869	[d] 333,756	[d] 371,588	(a)	(a)
Russia	55,062	(a)	(a)	(a)	(a)	(a)
Servia	36,255	(e)	45,462	(a)	(a)	(a)
Spain	[f] 289,551	[f] 339,448	[f] 414,438	912,316	(a)	(a)
Sweden	25,044	29,622	31,334	33,779	(a)	(a)
Turkey	[g] 148,130	[g] 104,823	[g] 121,260	(a)	(a)	(a)
United Kingdom	9,380	10,114	10,522	11,427	11,654	(a)
Asia:						
Japan	78,421	72,585	74,594	(a)	(a)	(a)
Oceania:						
Australia	2,916	2,496	(a)	(a)	(a)	(a)
	2,264,378	2,335,699	2,830,803	3,304,551	.....	.....
Sulphur displaced [h]	1,018,970	1,051,065	1,273,861	1,487,048	.....	.....

[a] Statistics not available.
[b] Prussia. Statistics for German Empire not available.
[c] Cupreous iron pyrites.
[d] 1911: Composed of cupreous iron pyrites, 9,595 long tons, and sulphur ore, 263,274 long tons; 1912 and 1913: Sulphur ore.
[e] Quantity not stated. Value, $54,101.
[f] Also 3,180,530 long tons in 1910, 3,232,465 long tons in 1911, and 3,313,145 long tons in 1912, designated as "copper ore and cupreous iron pyrites."
[g] Exported from Stratoni.
[h] Based on estimated 45 per cent of sulphur content.

PYRITE INDUSTRY BY STATES.

CALIFORNIA.

California ranked second among the States in both output and value of pyrite in 1915. The production was 132,270 long tons, valued at $496,111, an increase of 60,998 tons in quantity and of $260,982 in value. California pyrite came as usual from the vicinity of Oakland, Alameda County, and from Keswick, Shasta County. The Dairy Farm Mining Co., operated anew at Vantrent, Placer County.

GEORGIA.

Georgia ranked seventh in quantity and fifth in value of pyrite in 1915—a decrease in production compared with 1914. The pyrite came from the vicinity of Creighton, Cherokee County, where the Standard Pyrites Co. operated, and from Villa Rica, Carroll County, where the Sulphur Mining & Railroad Co. was at work.

ILLINOIS.

Illinois ranked fourth among the States in quantity and eighth in value of the pyrite produced in 1915. The production of the State was 14,849 long tons, valued at $22,476, a decrease of 7,689 tons in quantity and of $36,603 in value, compared with 1914.

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Much of the so-called pyrite obtained in coal mining, not only in Illinois but in Ohio, Indiana, and Pennsylvania, is not pyrite at all, but marcasite. Marcasite has the same composition as pyrite and is with difficulty distinguished from it, especially when in massive form. Both sulphides are commonly referred to by the miners as "sulphur." Marcasite has a slightly lower specific gravity than pyrite (pyrite 4.95 to 5.10; marcasite, 4.85 to 4.90). Its color when fresh, or after treatment with acids, is paler than that of pyrite. When crystallized, it is easily distinguished by its form—marcasite is orthorhombic in form; pyrite crystallizes in the isometric system. With pyrite, moreover, there are certain forms which, like the cube and the pyritohedron, are exceedingly common. Marcasite tarnishes and decomposes more readily than pyrite.

Pyrite in Illinois in 1915 came from in or near Danville, Batestown, Catlin, Oakwood, and Tilton, Vermilion County; and from Glen Carbon, Madison County. The total output of the State was made up of small quantities from many mines.

INDIANA.

The production of pyrite in Indiana in 1915 was 972 long tons, valued at $3,080; a decrease of 738 tons in quantity and of $2,201 in value, compared with 1914. Pyrite in Indiana is a by-product obtained in mining coal and in 1915 it came from West Terre Haute, Seelyville, and Macksville, Vigo County.

MISSOURI.

Two companies produced pyrite in Missouri in 1915, namely, the Rolla Mining Co., at Rolla, Phelps County, and the Beulah Mining Co., at Kelso, Scott County.

NEW YORK.

During 1915 pyrite came from two localities in New York. The St. Lawrence Pyrites Co. operated the Anna mine, at Hermon, St. Lawrence County; and production was also reported from the Northern Ore Co., at Edwards, St. Lawrence County. The pyrite concentrates produced at Edwards are obtained in the concentration of zinc ore. The Cole mine near Gouverneur, which has been worked for many years by the Hinckley Fiber Co., was shut down during the entire year. New York ranked third among the States in both quantity and value of the pyrite produced.

OHIO.

The production of pyrite in Ohio in 1915 was 10,857 long tons, valued at $27,404, an increase of 3,578 tons in quantity and of $7,686 in value, compared with 1914. The production without doubt would have been much larger had it not been for the fact that several of the mines producing by-product pyrite were idle for long periods. The pyrite came chiefly from New Philadelphia, Beidler, Dennison, Joyce, Midvale, Mineral City, Roswell, Uhrichsville, and Wainwright, Tuscarawas County; Tippecanoe, Harrison County; Brilliant, Connorville, Dillonvale, Herrick, and Rayland, Jefferson County.

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PENNSYLVANIA.

A small quantity of pyrite was produced in connection with coal mining in Clearfield County in 1915.

SOUTH CAROLINA.

An important production of pyrite was reported from Kershaw County by A. K. Blakeney.

VIRGINIA.

Virginia, as usual, ranked first among the States in both output and value of pyrite in 1915, there being marketed 145,050 long tons of pyrite, valued at $729,644, an increase of 3,774 tons in quantity and of $173,553 in value. The great increase in value was due to the demand for the pyrite for use in making acid, a demand which greatly increased toward the end of the year and continued in 1916.

The pyrite came from the Arminius mine, of the Arminius Chemical Co.; the mine of the Sulphur Mining & Railroad Co., and the Boyd-Smith mine, all near Mineral, Louisa County; from the Gossan mine, of the General Chemical Co., at Monarat, Carroll County; and from the Bertha Mineral Co., Austinville, Wythe County. The Cabin Branch Mining Co., which heretofore has been an important producer of pyrite at Dumfries, Prince William County, reported no output in 1915.

WISCONSIN.

The pyrite (marcasite) produced in southwestern Wisconsin and northwestern Illinois combined is given in this report as produced in Wisconsin, because nearly all the production comes from Wisconsin, and also because it is impossible to differentiate the production of the two States—a condition caused by the fact that low-grade blende containing marcasite and originating in both States is shipped to separating plants in both States, so that it is impossible to credit correctly the original State quotas. Part of this pyrite is obtained with the zinc ores mined in the southwestern part of Wisconsin, in what is usually known as the Wisconsin or upper Mississippi Valley zinc district, which includes also Illinois and Iowa, though no zinc ore was produced in Iowa in 1915. The zinc sulphide and the iron sulphide from both States are separated at Linden, Platteville, Cuba City, and Mineral Point, Wis., and at Galena, Ill.

SULPHURIC ACID.

CONDITION OF THE INDUSTRY.

There is no foreign competition in sulphuric acid, because of heavy transportation charges and because the American producers have been able to make this and other acids, like nitric and hydrochloric, at prices which render their importation unprofitable. Until about the middle of 1915 American manufacturers were able to supply all domestic needs, but as the war in Europe went on and the demand for munitions increased, the need of sulphuric acid became so great

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that manufacturers have had great difficulty in supplying the demand. As a consequence, many American consumers have been unable to get enough acid for their technochemical operations—for example, in the manufacture of the soluble or acid phosphates used in the fertilizer industry.

Prices have increased prodigiously, especially for the stronger grades of acid. By-product acid smelters that were compelled to install acid-making plants have been and are in a position to reap most unexpected profits. Indeed, what was formerly the by-product has in one place become the main product, and the metal has become the secondary product.

Important additions have been made to existing plants, new plants have been constructed at many places, and plants that were formerly idle have been put in operation. Ordinary concentration plants for producing the strongest grades of acid may be built in a comparatively short time but not plants designed for the production of acid itself. It takes time to construct these complex, elaborate plants, but in spite of the high cost of labor and material much capital is being invested in them. The output of these plants will be seen in the country's production for 1916.

PRODUCTION.

The production, in 1915, expressed in terms of 50° acid, was 3,868,152 short tons, valued at $29,869,080, to which must be added 189,795 short tons of oleum, or fuming acid of different strengths, valued at $2,787,971, a total of 4,057,947 short tons, valued at $32,657,051. These figures include by-product acid—that is, acid produced at copper and zinc smelters. The production of acid from this source in 1915, expressed in terms of 50° acid, was 1,056,830 short tons, valued at $7,042,126, together with 59,189 short tons of oleum of different strengths, valued at $579,115.

Sulphuric acid produced in the United States in 1899, 1904, 1909, 1914, and 1915.

Grade.	1899			1904			1909		
	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.	Price per ton.	Quantity short tons).	Value.	Price per ton.
50° Baumé.[a]	953,439	$7,965,832	$8.35	1,169,141	$8,314,646	$7.11	1,624,178	$8,494,451	$5.23
60° Baumé	17,012	246,284	14.47	48,688	581,523	11.94	186,900	1,089,350	5.78
66° Baumé	382,279	6,035,069	15.78	411,165	5,917,699	14.38	558,078	6,719,259	12.04
Other grades				[a] 13,268	361,018	27.20	[a] 31,349	476,135	15.18
	1,352,730	14,247,185		1,642,262	15,174,886		2,400,505	16,779,195	
Total reduced to 50° Baumé	[b]1,548,123		9.20	[c]1,869,437			[d]2,748,527		

[a] Reported as oleum by the census.

[b] Includes 764,355 tons, with an assigned value of $7,032,066, consumed in establishments where manufactured; and also sulphuric acid produced by establishments engaged primarily in the manufacture of other products.

[c] Includes 968,445 tons, with an assigned value of $7,232,675, consumed in establishments where manufactured; and also sulphuric acid produced by establishments engaged primarily in the manufacture of other products.

[d] Includes 1,271,535 tons, with an assigned value of $6,694,436, consumed in establishments where manufactured; and also sulphuric acid produced by establishments engaged primarily in the manufacture of other products.

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Sulphuric acid produced in the United States in 1899, 1904, 1909, 1914, and 1915—Continued.

Grade.	1914			1915		
	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.	Price per ton.
50° Baumé	1,628,402	$9,712,056	$5.96	[a] 1,518,271	$10,681,246	$7.04
60° Baumé	551,955	3,376,242	6.12	657,076	4,976,453	7.57
66° Baumé	916,192	10,509,471	11.47	1,019,024	14,211,381	13.95
Other grades	65,890	882,158	13.39	[b] 189,795	2,787,971	14.69
	3,162,439	24,479,927	7.74	3,384,166	32,657,051	9.65
Total reduced to 50° Baumé	[c] 3,762,417	[a] 24,163,331	6.42	[d] 3,868,152	29,869,080	7.72

[a] Includes not only acid reported as 50°, but also 52°, 53°, and 55° acid reduced to the equivalent.
[b] Includes stronger acid reported as oleum, etc., carrying varying percentages of free SO_3.
[c] Exclusive of 21,993 short tons of fuming acid, not convertible, valued at $316,596.
[d] Exclusive of "other grades."

PRODUCTION AT COPPER AND ZINC SMELTERS.

Sulphuric acid produced at copper and zinc smelters, 1912–1915.[a]

[Reduced to 60° Baumé acid.]

Source.	1912			1913		
	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.	Price per ton.
Copper smelters	[b] 321,156	[b] $1,985,704	[b] $6.18	336,019	$2,205,627	$6.56
Zinc smelters	[b] 292,917	[b] 2,255,237	[b] 7.70	296,218	2,140,645	7.23
	[b] 614,073	[b] 4,240,941	[b] 6.91	632,237	4,346,272	6.87
Total reduced to 50° Baumé	[c] 764,237	.....	.....	790,296	.....	.....

Source.	1914			1915		
	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.	Price per ton.
Copper smelters	348,727	$2,215,690	$6.25	360,522	$2,749,633	$7.63
Zinc smelters	411,911	2,974,603	7.22	484,942	4,292,493	8.85
Other strengths	.....	.....	.....	[d] 59,189	579,115	9.78
	760,638	5,190,293	6.82	904,653	7,621,241	8.42
Total reduced to 50° Baumé	950,798	.....	.....	[e] 1,056,830	.....	.....

[a] The acid reported to the Survey includes that of 50°, 53°, 55°, 60°, and 66° Baumé strengths, and a small quantity of electrolyte and oleum. All strengths, with the exception of the electrolyte, have been reduced to both 50° and 60° Baumé, as given in the table.
[b] Inclusive of a small quantity of electrolyte.
[c] Exclusive of a small quantity of electrolyte.
[d] Includes stronger acid reported as oleum, etc., carrying varying percentages of free SO_3.
[e] Exclusive of "Other strengths."

During the last few years it has been customary, in giving statistics of production, to reduce different strengths of acid to reported 50° Baumé whenever sufficient data were available for conversion, but as the production of stronger acid is becoming more important this is now classed separately and no reduction is made in terms of 50° acid.

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Too much weight must not be attached to the values given in the tables, for the prices of sulphuric acid have varied widely during the year. Producers who had previously entered into long-time contracts sold acid at prices much below those now current, especially during the last part of 1915. The trade in strong acids was active on account of the demand for explosives and other war munitions, but this demand came only after the first quarter of 1915 and was very strong only during the last half of the year. Before that time some acid plants were shut down. The average prices given are, therefore, much below those which ruled on the market at the close of the

GENERAL USES.

Sulphuric acid is probably used in a greater variety of ways in the chemical arts than any other substance. According to Lunge,[1] the principal applications of the acid are as follows:

1. *In a more or less dilute state (say from 144° Twad. downward).*—For making sulphate of soda (salt cake) and hydrochloric acid, and therefore ultimately for soda ash, bleaching powder, soap, glass, and innumerable other products. Further, for superphosphates and other artificial manures. These two applications probably consume nine-tenths of all the sulphuric acid produced. Further applications are for preparing sulphurous, nitric, phosphoric, hydrofluoric, boric, carbonic, chromic, oxalic, tartaric, citric, acetic, and stearic acids; in preparing phosphorus, iodine, bromine, the sulphates of potassium, ammonium, barium (blanc fixe), calcium (pearl-hardening); especially also for precipitating baryta or lime as sulphates for chemical processes; sulphates of magnesium, aluminum, iron, zinc, copper, mercury (as intermediate stage for calomel and corrosive sublimate); in the metallurgy of copper, cobalt, nickel, platinum, silver; for cleaning (pickling) sheet iron to be tinned or galvanized for cleaning copper, silver, etc.; for manufacturing potassium bichromate; for working galvanic cells, such as are used in telegraphy, in electroplating, etc.; for manufacturing ordinary ether and the composite ethers; for making or purifying many organic coloring matters, especially in the oxidizing mixture of potassium bichromate and sulphuric acid; for parchment paper; for purifying many mineral oils, and sometimes coal gas; for manufacturing starch, sirup, and sugar; for the saccharification of corn; for neutralizing the alkaline reaction of fermenting liquors, such as molasses; for effervescent drinks; for preparing tallow previously to melting it; for recovering the fatty acids from soapsuds; for destroying vegetable fibers in mixed fabrics; generally, in dyeing, calico printing, tanning, as a chemical reagent in innumerable cases; in medicine against lead poisoning, and in many other cases.

2. *In a concentrated state.*—For manufacturing the fatty acids by distillation; purifying colza oil; for purifying benzene, petroleum, paraffin oil, and other mineral oils; for drying air, especially for laboratory purposes, but also for drying gases for manufacturing processes (for this, weaker acid also, of 140° Twad., can be used); for the production of ice by the rapid evaporation of water in a vacuum; for refining gold and silver, desilvering copper, etc.; for making organo-sulphonic acids; manufacturing indigo; preparing many nitro compounds and nitric ethers, especially in manufacturing nitroglycerin, pyroxylin, nitrobenzene, picric acid, and so forth.

3. *As Nordhausen fuming oil of vitriol (anhydride).*—For manufacturing certain organo-sulphonic acids (in the manufacture of alizarin, eosin, indigo, etc.); for purifying ozokerite; for making shoe blacking; for bringing ordinary concentrated acid up to the highest strength as required in the manufacture of pyroxylin; and for other purposes.

The most important of the classes of manufacture enumerated above, so far as the consumption of the acid is involved, are (1) the manufacture of fertilizers; (2) the refining of petroleum products; (3) the iron, steel, and coke industries; (4) the manufacture of nitrocellulose, nitroglycerin, celluloid, etc.; and (5) general metallurgical and chemical practice.

[1] Manufacture of sulphuric acid and alkali, vol. 1, pt. 2, pp. 1169, 1170, 1903.

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A NEW USE FOR SULPHURIC ACID.

A prospective use for sulphuric acid which has large possibilities has been proposed by C. B. Lippman, of the University of California.[1] The announcement is to the effect that apparently beneficial results have been obtained from the application of sulphuric acid to the alkali soils of the West. Views were shown at the convention of engineers last fall in San Francisco exhibiting crops grown on test plots that had received 2.5 to 7.5 tons of sprayed sulphuric acid to the acre. The ground prior to the application had been unfit for agriculture, owing to its content of alkali. There is much alkali land around certain acid plants and, in fact, in many other parts of the West. Thus the possibility of advantageously converting damaging fumes from western smelters into a useful product and finding a local outlet for the product under normal conditions is one of great importance to the West. The development of this application will no doubt be watched with much interest.

[1] Eng. and Min. Jour., vol. 100, Oct. 30, 1915.

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MINERAL WATERS.

By RICHARD B. DOLE.

CHARACTER OF STATISTICS.

The statistics here given have been compiled from individual reports furnished by the owners or operators of springs and include, so far as can be ascertained, only natural waters that are bottled and sold in their natural state or only slightly altered from their natural state. Natural still waters that have been artificially carbonated, natural carbonated waters that have lost part of their carbon dioxide, and waters from which iron has been removed are included; but artificial waters and natural waters that have been flavored, concentrated, fortified, diluted, or otherwise essentially modified in chemical character are excluded if available information indicates such treatment. Water given away or consumed at spring resorts, which constitutes a large part of the annual production, is excluded. Waters sold at flat or meter rates, delivered to consumers through pipes, or otherwise obviously municipal supplies or adjuncts to them are excluded. This is the nearest practicable conformity with the commonly accepted definition of natural mineral water. No distinction is made between mineral water flowing or pumped from a natural spring and that flowing or pumped from a dug, bored, driven, or drilled well. Many of the best-known mineral waters in the United States come not from natural springs but from wells.

Distinction for statistical purposes between table and medicinal waters is entirely arbitrary. Most table waters are clear, sparkling, and without distinct mineral taste or odor; many medicinal waters are highly mineralized and have distinct mineral taste and odor. Yet some table waters are more strongly mineralized than some medicinal waters, and many medicinal waters contain less mineral matter than certain city supplies. The basis here used for distinguishing medicinal from table waters is the report regarding the spring, and this distinction is based in turn on the operator's knowledge that some of his customers buy the water to use regularly on their tables and others buy it for an aid during illness. A few strongly mineralized waters are not sold as table waters, and a few widely sold table waters are not used medicinally, but many waters are sold for both uses, though the reported sales of several medicinal waters have distinctly decreased in the last few years.

MINERAL-WATER TRADE IN 1915.

OUTPUT AND VALUE.

The number of active mineral springs was smaller and the production was less though the value was greater in 1915 than in 1914. The decrease in production was 2,244,963 gallons, or 4 per cent. The increase in value of medicinal waters was $60,506 and in value of table waters was $185,960; thus the total increase in value of sales

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was $246,466, or 5 per cent. The increase in business is slightly less than the decrease in imports of foreign waters, and this, coupled with the increase of price per gallon from 9 to 10 cents, indicates increased sales of moderately high-priced domestic waters that have become valuable substitutes for waters previously imported. Production was reported from 45 springs for the first time in 1915.

The State of New York led in number of commercial springs and in quantity of mineral water sold, and was second to Wisconsin in total value of production and in value of table waters, though it ranked only seventh in value of medicinal waters, in which California and Indiana took, respectively, first and second rank. Virginia and Texas were also heavy producers of medicinal waters. In value of table waters California, Maine, Massachusetts, and Pennsylvania followed, in order, Wisconsin and New York. In total value of production Massachusetts, Ohio, Minnesota, and Virginia followed, in order, the same two States. More than 30 springs were active in each of 9 States, more than 1,000,000 gallons of mineral water was sold in each of 15 States, and more than $100,000 worth of mineral water was produced in each of 15 States.

Mineral waters sold in the United States, 1914 and 1915.

1914.

State.	Commercial springs.	Quantity sold.	Average price per gallon.	Value of medicinal waters.	Value of table waters.	Total value.
		Gallons.	*Cents.*			
Alabama	15	169,279	10	$7,614	$9,511	$17,125
Arkansas	18	1,314,159	9	67,260	47,945	115,205
California	48	2,282,569	22	212,067	285,856	497,923
Colorado	12	968,260	12	7,132	106,281	113,413
Connecticut	42	2,341,082	6	2,301	132,177	134,478
Florida	11	231,160	11	3,315	21,423	24,738
Georgia	19	652,566	8	8,601	41,058	49,659
Illinois	21	1,760,030	5	3,586	77,721	81,307
Indiana	17	382,247	36	125,975	12,143	138,118
Iowa	7	303,527	10	15,141	15,038	30,179
Kansas	15	272,722	21	52,065	4,375	56,440
Kentucky	12	437,334	13	32,950	23,544	56,494
Louisiana	5	576,138	6	3,643	27,919	31,562
Maine	29	1,062,631	31	88,348	244,886	333,234
Maryland	10	1,691,776	7	0	124,403	124,403
Massachusetts	52	3,084,385	6	19,435	154,889	174,324
Michigan	22	931,343	8	12,252	58,058	70,310
Minnesota	15	5,639,232	3	509	193,532	194,041
Mississippi	8	415,904	18	72,100	968	73,068
Missouri	36	583,288	13	56,647	18,146	74,793
Montana	3	100,700	6	10	5,545	5,555
Nebraska	3	10,900	14	650	840	1,490
Nevada	3	221,942	1	0	3,191	3,191
New Hampshire	7	194,418	6	875	10,856	11,731
New Jersey	17	1,710,030	9	1,500	154,149	155,649
New Mexico	3	41,000	16	90	6,510	6,600
New York	69	8,201,202	8	61,845	611,068	672,913
North Carolina	17	158,226	14	16,496	5,468	21,964
North Dakota	4	408,000	2	1,050	7,100	8,150
Ohio	35	3,558,413	4	19,232	126,354	145,586
Oklahoma	12	804,675	3	2,697	24,209	26,906
Oregon	7	57,800	22	2,115	10,695	12,810
Pennsylvania	47	2,457,626	9	11,372	202,380	213,752
Rhode Island	6	438,702	7	0	29,639	29,639
South Carolina	13	293,949	16	41,231	6,840	48,071
South Dakota	3	145,647	6	508	8,491	8,999
Tennessee	23	943,502	6	35,102	21,639	56,741
Texas	31	766,597	12	91,542	1,472	93,014
Vermont	4	51,151	17	1,700	6,900	8,600
Virginia	50	2,906,976	10	107,332	186,180	293,512
Washington	6	180,787	16	19,062	9,715	28,777
West Virginia	10	307,890	16	19,702	29,427	49,129
Wisconsin	35	5,145,452	11	69,412	518,961	588,373
Wyoming	3	69,658	13	3,950	4,852	8,802
Other States [a]	4	63,291	2	23	1,537	1,560
	829	54,358,466	9	1,298,437	3,593,891	4,892,328

[a] Includes Delaware, District of Columbia, and Utah.

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Mineral waters sold in the United States, 1914 and 1915—Continued.

1915.

State.	Commercial springs.	Quantity sold.	Average price per gallon.	Value of medicinal waters.	Value of table waters.	Total value.
		Gallons.	*Cents.*			
Alabama	14	86,499	10	$8,213	$699	$8,912
Arkansas	13	1,377,093	9	70,862	48,210	119,072
California	50	2,789,871	19	206,181	326,636	532,817
Colorado	14	858,185	7	6,543	56,561	63,104
Connecticut	38	1,774,213	6	5,991	95,979	101,970
Florida	7	118,920	11	1,476	11,040	12,516
Georgia	19	746,068	7	9,207	44,572	53,779
Illinois	23	1,559,489	5	5,382	69,908	75,290
Indiana	18	542,053	35	172,215	16,859	189,074
Iowa	8	198,739	9	7,252	11,282	18,534
Kansas	14	155,938	40	59,721	3,348	63,069
Kentucky	11	459,841	14	47,300	15,978	63,278
Louisiana	5	513,838	6	3,307	27,464	30,771
Maine	24	1,115,648	30	89,148	248,855	338,003
Maryland	10	1,433,406	7	0	105,581	105,581
Massachusetts	48	3,872,192	5	14,598	169,535	184,133
Michigan	19	913,765	8	5,165	67,546	72,711
Minnesota	17	3,493,887	4	1,197	135,062	136,259
Mississippi	11	259,370	18	44,460	1,179	45,639
Missouri	33	1,000,961	8	65,394	17,969	83,363
Montana	3	114,245	6	55	6,548	6,603
Nebraska	3	8,770	11	145	817	962
Nevada	3	303,150	1	0	4,294	4,294
New Hampshire	7	176,385	4	875	5,862	6,737
New Jersey	13	1,479,479	8	2,520	113,706	116,226
New Mexico	4	42,400	16	4,370	2,310	6,680
New York	75	8,411,616	8	74,023	637,674	711,697
North Carolina	17	132,813	14	14,907	3,838	18,745
North Dakota	3	475,000	2	750	8,000	8,750
Ohio	36	3,504,343	4	10,923	122,493	133,416
Oklahoma	13	890,392	3	5,860	18,145	24,005
Oregon	7	28,747	30	1,942	6,787	8,729
Pennsylvania	47	2,136,218	8	11,733	163,065	174,798
Rhode Island	6	385,624	6	0	24,574	24,574
South Carolina	11	480,051	14	61,452	6,417	67,869
South Dakota	3	176,000	5	0	9,360	9,360
Tennessee	23	703,566	6	21,584	17,720	39,304
Texas	29	835,142	12	99,700	390	100,090
Vermont	5	61,540	23	4,250	10,132	14,382
Virginia	50	3,027,528	8	108,943	128,875	237,818
Washington	5	158,865	7	6,150	5,553	11,703
West Virginia	9	314,909	16	19,751	30,520	50,271
Wisconsin	36	4,861,734	22	81,395	970,010	1,051,405
Wyoming	5	68,584	13	4,000	5,059	9,059
Other States [a]	3	66,426	5	3	3,439	3,442
	812	52,113,503	10	1,358,943	3,779,851	5,138,794

[a] Includes Delaware and Utah.

Sales were reported from 812 springs in 1915 as compared with 829 in 1913. No reports of mineral-water sales were received from Arizona, District of Columbia, or Idaho, and less than three active springs were reported from Delaware and Utah; three or more springs were active in every other State in the Union. Sales exceeded 5,000,000 gallons in one State (New York), and in one State (Wisconsin) the total production was valued at more than $1,000,000. The total value of the output exceeded $500,000 in Wisconsin, New York, and California, and these three States produced 31 per cent of the total quantity and 45 per cent of the total value of domestic mineral waters marketed in 1915.

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CONDITION OF TRADE.

Though the total value of production in 1915 exceeded that in 1914 the maximum production and value of 1911 were not equaled. There seems to be a general tendency toward increased sales of table waters, decreased sales of medicinal waters, decreased number of active springs, and greatly increased sales of a few waters. The statistics of production in the United States during the last five years, shown in the following table, indicate a gradual decline in quantity sold since 1911.

Mineral waters sold in the United States, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	732	63,788,552	$6,837,868	11
1912	746	62,281,201	6,615,671	11
1913	838	57,867,399	5,631,391	10
1914	829	54,358,466	4,892,328	9
1915	812	52,113,503	5,138,794	10

In 1915, as in 1913 and 1914, nearly half the trade in mineral waters was in the hands of a few very large producers. Five springs, as in 1913 and 1914, sold more than 1,000,000 gallons each, and 16 springs, as compared with 18 in 1914 and 20 in 1913, sold more than 500,000 gallons each. The total output of these 16 springs was 18,483,823 gallons, valued at $2,016,445. The total output of the 20 largest producers in 1915 was 20,312,142 gallons, valued at $2,087,895, as compared with an output by the 20 largest producers in 1914 of 21,356,203 gallons, valued at $1,636,316. Fifty springs in 1915 did more than $20,000 worth of business each, selling a total of 23,717,725 gallons for $3,421,153. Fifty-one springs in 1914 did more than $20,000 worth of business each, selling a total of 26,731,787 gallons for $3,050,563. Corresponding figures for 1913 are 54 springs, 28,769,596 gallons, and $3,642,964. The decrease in quantity of mineral waters sold in 1915 by the large producers is equivalent to 11 per cent and the increase in value is equivalent to 12 per cent. These differences indicate a tendency toward increase in price during 1915. In addition to those large producers, however, there were 762 others whose sales ranged from $5 to $20,000 and whose fields of activity are general. The details of the fluctuations in the trade by States are given in the accompanying table.

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Comparative production of mineral waters, 1914–1915.

State.	1914			1915			Increase or decrease in number of springs.	Increase or decrease in quantity sold.		Increase or decrease in value of product.	
	Commercial springs.	Quantity sold.	Value.	Commercial springs.	Quantity sold.	Value.		Gallons.	Per cent.	Dollars.	Per cent.
		Gallons.			Gallons.						
Alabama	15	169,279	$17,125	14	86,499	$8,912	− 1	− 82,780	−49	− 8,213	− 48
Arkansas	18	1,314,159	115,205	13	1,377,093	119,072	− 5	+ 62,934	+ 5	+ 3,867	+ 3
California	48	2,382,569	497,923	50	2,789,871	532,817	+ 2	+ 507,302	+22	+ 34,894	+ 7
Colorado	12	968,260	113,412	14	858,185	63,104	+ 2	− 110,075	−11	− 50,309	− 44
Connecticut	42	2,341,082	124,478	38	1,774,213	101,970	− 4	− 566,869	−24	− 22,508	− 24
Florida	11	231,160	24,738	7	118,920	12,516	− 4	− 112,240	−49	− 12,222	− 49
Georgia	19	652,566	49,659	19	746,068	53,779	0	+ 93,502	+14	+ 4,120	+ 8
Illinois	21	1,760,080	81,307	23	1,559,489	75,290	+ 2	− 200,541	−11	− 6,017	− 7
Indiana	17	382,247	133,118	18	542,053	189,074	+ 1	+ 159,806	+42	+ 50,956	+ 37
Iowa	7	303,827	30,179	8	198,739	18,534	+ 1	− 105,088	−35	− 11,645	− 39
Kansas	15	272,722	56,440	14	155,938	63,069	− 1	− 116,784	−43	+ 6,629	+ 12
Kentucky	12	437,334	56,494	11	459,841	63,278	− 1	+ 22,507	+ 5	+ 6,784	+ 12
Louisiana	5	576,138	31,562	5	513,338	30,771	0	− 62,800	−11	− 791	− 3
Maine	29	1,062,631	333,234	24	1,115,648	338,003	− 5	+ 53,017	+ 3	+ 4,769	+ 1
Maryland	10	1,691,776	124,403	10	1,433,406	105,581	0	− 258,370	−15	− 18,822	− 15
Massachusetts	52	3,084,325	174,324	48	3,872,192	184,133	− 4	+ 787,807	+26	+ 9,809	+ 6
Michigan	22	931,343	70,310	19	913,765	72,711	− 3	− 17,578	− 2	+ 2,401	+ 3
Minnesota	15	5,699,282	194,041	17	3,493,887	136,259	+ 2	−2,145,345	−38	− 57,782	− 30
Mississippi	8	415,904	73,068	11	259,370	45,639	+ 3	− 156,534	−38	− 27,429	− 38
Missouri	36	583,288	74,793	33	1,000,961	83,363	− 3	+ 417,673	+72	+ 8,570	+ 12
Montana	3	100,700	5,555	3	114,245	6,603	0	+ 13,545	+14	+ 1,048	+ 19
Nebraska	3	10,900	1,490	3	8,770	962	0	− 2,130	−20	− 528	− 35
Nevada	3	221,942	3,191	3	303,150	4,294	0	+ 81,208	+37	+ 1,103	+ 35
New Hampshire	7	194,418	11,731	7	176,385	6,737	0	− 18,033	− 9	− 4,994	− 43
New Jersey	17	1,710,030	155,649	13	1,479,479	116,226	− 4	− 230,551	−14	− 39,423	− 25
New Mexico	3	41,000	6,600	4	42,400	6,680	+ 1	+ 1,400	+ 3	+ 80	+ 1
New York	69	8,201,202	672,913	75	8,411,616	711,697	+ 6	+ 210,414	+ 3	+ 38,784	+ 6
North Carolina	17	156,226	21,964	17	132,813	18,745	0	− 25,413	−16	− 3,219	− 15
North Dakota	4	408,000	8,150	3	475,000	8,750	− 1	+ 67,000	+16	+ 600	+ 7
Ohio	35	3,558,413	145,586	36	3,504,343	133,416	+ 1	− 54,070	− 2	− 12,170	− 8
Oklahoma	12	804,675	26,906	13	899,392	24,005	+ 1	+ 85,717	+11	− 2,901	− 11
Oregon	7	57,900	12,810	7	28,747	8,729	0	− 29,053	−50	− 4,081	− 32
Pennsylvania	47	2,457,626	213,752	47	2,136,218	174,798	0	− 321,408	−13	− 38,954	− 18
Rhode Island	6	438,702	29,639	6	385,624	24,574	0	− 53,078	−12	− 5,065	− 17
South Carolina	13	298,949	48,071	11	480,051	67,869	− 2	+ 186,102	+63	+ 19,798	+ 41
South Dakota	3	145,647	8,999	3	176,000	9,360	0	+ 30,353	+21	+ 361	+ 4
Tennessee	23	943,502	56,741	23	703,566	39,304	0	− 239,936	−25	− 17,437	− 31
Texas	31	766,597	93,014	29	835,142	100,090	− 2	+ 68,545	+ 9	+ 7,076	+ 8
Vermont	4	51,151	8,600	5	61,540	14,382	+ 1	+ 10,389	+20	+ 5,782	+ 67

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BRINE SALT.

By the processes mentioned above are produced the different grades of salt made from brine, together with many modifications of them put on the market under different trade and proprietary names.

Brine salt marketed in the United States, 1911–1915.

Year.	Table and dairy.		Packers' salt.					
			Common fine.		Common coarse.		Packers'.	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1911	3,773,798	$2,528,671	6,267,850	$2,048,527	2,970,492	$1,041,619	408,928	$162,945
1912	3,961,450	3,164,638	6,021,052	2,109,076	2,753,375	1,096,643	751,551	296,238
1913	3,881,387	3,223,836	6,521,058	2,423,012	3,464,978	1,414,760	(a)	(a)
1914	4,121,574	3,221,007	6,237,860	2,383,588	3,789,163	1,453,484	.....	.....
1915	4,341,063	3,720,020	7,013,055	2,762,450	3,834,101	1,724,503	.....	.....

Year.	Coarse solar.		Other grades.		Brine.		Total.	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1911	1,343,046	$444,324	160,233	$40,365	10,027,411	$501,225	24,951,758	$6,767,676
1912	1,105,985	408,939	281,063	59,093	11,408,623	570,316	26,233,049	7,704,943
1913	1,161,649	446,342	193,991	67,608	11,588,444	579,014	26,811,507	8,154,572
1914	1,080,199	451,206	193,301	73,715	11,805,414	589,519	27,227,511	8,172,519
1915	1,161,208	508,402	335,019	130,452	13,222,848	601,965	29,907,304	9,447,792

[a] A small output reported directly as packers' is included under common coarse.

ROCK SALT.

Rock salt marketed in the United States, 1911–1915.

Year.	Rock salt.	
	Quantity (short tons).	Value.
1911	[a] 872,509	$1,578,016
1912	[b] 992,846	1,697,829
1913	[b] 1,062,291	1,968,567
1914	[b] 1,060,804	2,024,898
1915	[b] 1,165,387	2,299,894

[a] Includes California, Idaho, Kansas, Louisiana, Michigan, New York, and Utah.
[b] Includes California, Kansas, Louisiana, Michigan, New York, and Utah.

Rock salt is produced by deep-shaft mining in the eastern, central, and southern parts of the United States. The 9 active mines are located, 1 each at Retsof and at Halite, Livingston County, N. Y.; 1 near Detroit, Mich.; 3 at Kanopolis, Ellsworth County, and 1 at Lyons, Rice County, Kans.; and 1 each at Weeks and Avery islands, Iberia Parish, southern Louisiana.

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Rock salt occurs near the surface in consequence of the dry climate, and is mined in open cuts or pits in Sevier Valley near Redmond, in both Sevier and Sanpete counties, Utah. A small production of rock salt from near the surface is also reported near Ward, San Bernardino County, Cal. Some rock salt has been produced as the result of development work by the Avawatz Salt & Gypsum Co., in the Avawatz Mountains, San Bernardino County, Cal.

PRODUCTION BY STATES.

Salt of domestic production marketed in the United States, 1912–1915.

State.	1912		1913		1914		1915	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
Michigan	10,946,739	$2,974,429	11,528,800	$3,293,032	11,670,976	$3,299,005	12,588,788	$4,304,731
New York	10,527,221	2,615,334	10,780,514	2,865,187	10,389,314	2,824,733	11,217,471	2,976,405
Ohio	5,269,179	1,364,136	5,310,135	1,318,156	5,482,836	1,320,554	5,880,243	1,462,192
Kansas	2,573,626	844,292	2,698,079	860,404	2,967,864	924,550	3,765,164	1,035,879
California	1,090,000	620,196	1,082,993	759,485	1,100,443	782,920	1,048,457	694,070
West Virginia	139,121	66,023	113,921	63,803	145,429	78,036	232,239	115,143
Texas	373,064	290,328	355,529	278,008	334,979	251,493	444,978	345,944
Utah	283,293	154,734	330,443	191,686	375,457	231,512	394,850	266,334
Hawaii	8,286	9,180	6,071	5,950	.....	.....	(a)	(a)
Idaho	(a)	(a)	(a)	(a)	300	520	(a)	(a)
Nevada	12,536	15,752	8,971	7,947	4,436	2,448	6,929	3,950
Other States	[b]2,101,743	448,368	[b]2,183,842	479,481	[c]2,332,649	481,646	[d]2,652,377	543,038
Total	33,324,808	9,402,772	34,399,298	10,123,139	34,804,683	10,197,417	38,231,496	11,747,686

[a] Included in "Other States."
[b] Includes Idaho, Louisiana, New Mexico, Oklahoma, Pennsylvania, Porto Rico, and Virginia.
[c] Includes Louisiana, New Mexico, Oklahoma, Pennsylvania, Porto Rico, and Virginia.
[d] Includes Hawaii, Idaho, Louisiana, New Mexico, Oklahoma, Porto Rico, and Virginia.

DOMESTIC CONSUMPTION.

The following table shows that the United States furnished very nearly all the salt consumed by its people in 1915. The excess of consumption over production was only 299,944 barrels, or 0.8 per cent. Of course part of our domestic production was exported, but the exports were more than offset by imports which, as shown in the table, were 2.3 per cent of the total consumption.

Supply of salt for domestic consumption, 1890–1915, in barrels.

Source.	1890	1900	1910	1913	1914	1915
Domestic production	8,876,991	20,869,342	30,305,656	34,399,298	34,804,683	38,231,496
Imports	1,838,024	1,427,921	979,305	1,105,466	934,319	873,760
Total	10,715,015	22,297,263	31,284,961	35,504,764	35,739,002	39,105,256
Exports	17,597	53,650	350,094	502,065	587,818	574,816
Domestic consumption	10,697,418	22,243,613	30,934,867	35,002,699	35,151,184	38,531,440
Comparison with preceding year	+877,610	+1,274,634	+46,032	+1,125,012	+148,485	+3,380,256
Percentage of imports to total consumption	17.2	6.4	3.2	3.2	2.7	2.3

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IMPORTS.

According to figures obtained from the Bureau of Foreign and Domestic Commerce, Department of Commerce, the quantity and value of the salt imported and entered for consumption into the United States in the last five years are as follows:

Salt imported and entered for consumption in the United States, 1911–1915.

Year.	In bags, barrels, and other packages.		In bulk.		For the purpose of curing fish.		Total quantity (pounds).	Total value.
	Quantity (pounds).	Value.	Quantity. (pounds).	Value.	Quantity (pounds).	Value.		
1911	61,648,200	$181,405	108,055,700	$95,801	114,475,300	$97,824	284,179,200	$375,030
1912	57,453,400	179,199	133,080,800	112,749	89,091,700	78,700	279,625,900	370,648
1913	70,433,300	209,752	185,743,900	160,400	[a] 53,353,300	[a] 51,593	309,530,500	421,745
1914	65,614,400	212,349	195,994,500	168,454	.....	.....	261,608,900	380,803
1915	57,449,100	196,593	187,203,600	169,859	.....	.....	244,652,700	366,452

[a] This class was not carried separately after Oct. 3, 1913.

EXPORTS.

The exports of salt in 1915 were 160,948,389 pounds (574,816 barrels), valued at $613,850. Though the quantity exported decreased 3,640,623 pounds (13,002 barrels), the value of the exports advanced considerably even as compared with the much larger quantity exported in 1914.

Salt of domestic production exported from the United States, 1911–1915.

Year.	Quantity (pounds).	Value.
1911	97,745,833	$335,285
1912	124,819,713	418,525
1913	140,578,092	515,194
1914	164,589,012	586,055
1915	160,948,389	613,850

SALT INDUSTRY, BY STATES.

CALIFORNIA.

California ranked sixth among the States in quantity and fifth in value of the salt produced in 1915. The quantity produced was 1,048,457 barrels (146,784 tons), valued at $694,070, a decrease of 51,986 tons in quantity and of $88,850 in value, compared with 1914.

There was little of special interest in the California salt industry in 1915. One producer in Alameda County reported a shortage caused by flood conditions. The Avawatz Salt & Gypsum Co. reported some development work on their rock-salt deposits in the Avawatz Mountains, San Bernardino County, and a new company, the Milligan Salt Co., reported having done experimental work at Milligan, San Bernardino County. Some salt was produced by John H. Keyes, about 9 miles east of Suisun, Solano County. The salt is obtained by solar evaporation from brine that issues from a gas well owned by the Rochester Oil Co.

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The salt industry in California is different from that in the other parts of the country. The great bulk of the output in this State comes from sea water. The salt "crop," so called, is "harvested" chiefly in the fall, and its size depends to a large extent on the weather.

The basic salt output in California is chiefly solar salt, and its sale either in the harvested form or after it has been crushed (half ground) or washed and ground for table and dairy use and is known as granulated, constitutes about 80 per cent of the trade. Three firms on the coast recrystalize their product. The cost of crude solar salt in the stack is fairly well established at $2.50 a ton. The price received f. o. b. shipping point, will vary with the varying demands of the industries supplied. The highest grades of salt, such as table and dairy, have practically a uniform market at all times and are not subject to the fluctuation of crude solar salt. The other grades marketed for curing hides, hay, fish, and for making ice cream, have varying prices, according to the work necessary to get them into condition for the market.

The headquarters of the salt industry in 1915 were at Alvarado, Newark, Mount Eden, Russell, and Baumberg (formerly Arffs), in Alameda County, on the east shore of San Francisco Bay, and at Redwood City and San Mateo, in San Mateo County, on the west side of the bay. In the southern part of the State solar salt was made near Long Beach, Los Angeles County, and at the head of San Diego Bay, San Diego County.

Coarse solar salt was also produced inland at Tramway (Keeler post office), Inyo County; Saltdale, Kern County; and at Cedarville, Modoc County. Some rock salt was produced at Ward, San Bernardino County.

IDAHO.

Salt was made by only one operator in Idaho in 1915 and the production came from Stump Creek, Bannock County, in the southeastern part of the State.

KANSAS.

Kansas ranked fourth among the States both in the quantity and the value of the salt marketed in 1915. The quantity produced was 3,765,164 barrels (527,123 tons), valued at $1,035,879, an increase of 797,300 barrels (111,622 tons) in quantity and of $111,329 in value, compared with 1914. Ten companies operated salt plants and mines in Kansas in 1915. Four companies mined rock salt, 3 mines being at Kanopolis, Ellsworth County, and 1 at Lyons, Rice County. Evaporated salt, that is, salt made in open pans, grainers, or vacuum pans, was produced by operators at Hutchinson, Reno County, which may be considered the main headquarters of this branch of the industry, at Anthony, Harper County, and at Lyons, Rice County. The Sterling Salt Co., which for many years has operated at Sterling, Rice County, did not produce in 1915, and reported no sales of salt left over from 1914.

The Short Grass Oil & Gas Co. reports that it has developed 600 feet of rock salt in a well in the SE. ¼ sec. 10 in the northwest township of Clark County, Kans. (T. 30 S., R. 25 W.). The top of the salt was struck at a depth of 690 feet and the topmost stratum of salt is 60 feet thick and is capped by limestone 12 feet in thickness. The next lower

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bed of salt is 158 feet thick with a thin bed of limestone between it and the overlying salt bed. Below this thick bed the salt layers vary in thickness from 5 to 30 feet. No water was encountered in the well from 500 to 2,900 feet, at which depth a small quantity of salt water was found in sand. From 3,300 to 3,700 feet a great deal of strong brine was encountered and the well caved, making it necessary to case down to about this lower level.

LOUISIANA.

Louisiana ranked fifth among the States in quantity and sixth in the value of the salt produced in 1915. Only two companies operated in the State, and to keep the returns of these companies confidential the total output of the State can not be given separately. Only rock salt was produced, which came from Averys Island (Petite Anse) and Weeks Island (Grand Cote).

The most important salt deposits of Louisiana are on the Five Islands, so called, near the southern coast. From two of these—Weeks Island (Grand Cote) and Averys Island (Petite Anse)—a large quantity of rock salt is produced. The only limit to the output of Louisiana salt is the demand, as the State can add greatly to its present production.

MICHIGAN.

Michigan ranked first among the States both in the quantity and the value of the output of salt in 1915. The quantity of salt produced was 12,588,788 barrels (1,762,430 tons), valued at $4,304,731, an increase of 917,812 barrels (128,494 tons) and of $1,005,726 in value compared with 1914.

The salt produced in Michigan is obtained (1) from rock salt and (2) from natural brines.

The rock-salt deposits now worked are in the southeastern and the western parts of the Lower Peninsula and are exploited in two ways: (1) Rock salt itself is actually mined from the deposits, and (2) water is allowed to come into contact with the salt and the brine thus formed, which may be considered artificial, is forced to the surface and there evaporated.

The salt industry of Michigan dependent on the natural brines is confined to the Saginaw Valley. The brine is entirely distinct, not only in its geographic but also in its geologic relations, from the salt in the southeastern and the western parts of the Lower Peninsula. With the salt production in the Saginaw Valley are connected the bromine and the calcium chloride industries. The manufacture of salt in Saginaw Valley is not so important as it is in the other parts of the Lower Peninsula.

Rock salt is mined at Oakwood, near Detroit, Wayne County. In the southeastern part of the State evaporated salt is made at Marine City, Port Huron, and St. Clair, in St. Clair County; at Oakwood, in the suburbs of Detroit; and at Delray, Ecorse, and Wyandotte, in Wayne County. In the western part of the State evaporated salt is made at Eastlake, Filer City, and Manistee, in Manistee County, and at Ludington, in Mason County. The R. G. Peter Salt & Lumber Co., which has operated for many years at Eastlake, near Manistee, reported no sales of salt in 1915. In the Saginaw Valley salt is made at Bay City, Bay County; Mount Pleasant, Isabella County; and at

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Carrollton, Saginaw, and St. Charles, in Saginaw County. Calcium chloride is also made at Mount Pleasant and Saginaw, and bromine at Midland, Mount Pleasant, Saginaw, Bay City, and St. Charles.

The bromine manufactured in Michigan is placed on the market partly as such and partly in the form of bromides. The demand from abroad has greatly stimulated the manufacture of bromine, and plants at Saginaw have engaged in the industry. After a lapse of some years in which no bromine was made, the bromine industry has again started up at St. Charles.

NEVADA.

The production of salt in Nevada in 1915 was 6,929 barrels (970 tons), valued at $3,950. This small production came from Sand Springs, near Fallon and from the Desert Crystal Salt Co., White Plains, Churchill County; and from the Buffalo Salt Works, Sheepshead, Washoe County. The Buffalo Salt Works are located in T. 32 N., R. 20 E., Mount Diablo meridian. C. W. Kinney, of Sand Springs, reports that the salt deposits in that locality are located 24 miles from the railroad but that a line is being built to the salt deposits which will be completed during 1916. A factory will also be built.

NEW MEXICO.

A production of salt was reported by the New Mexico Salt Co., at Lucy, Torrance County, N. Mex.

NEW YORK.

New York ranked second among the States in both quantity and value of the salt produced in 1915. The output was 11,217,471 barrels (1,570,446 tons), valued at $2,976,405, an increase of 828,157 barrels (115,942 tons) in quantity and of $151,672 in value. The output of the State falls into the several usual classes: Rock salt was mined at Halite (Cuylerville post office) and at Retsof, Livingston County; solar salt was produced in the vicinity of Syracuse, Onondaga County, but the crop in 1915 was the poorest in several years; brine utilized in the manufacture of soda products came from Tully, Onondaga County; evaporated salt, or salt made by artificial evaporation in open pans, grainers, or vacuum pans, from brines obtained by allowing water to come into contact with the rock salt in place, is the most important class made in the State and it was made at Le Roy, Genesee County; Piffard, Livingston County; Watkins, Schuyler County; Ithaca and Myers, Tompkins County; and at Rock Glen, Silver Springs, and Saltvale, Wyoming County.

On the whole the New York salt trade was much better in 1915 than in 1914, due in part to the falling off in competition from foreign salt along the Atlantic seaboard.

OHIO.

Ohio ranked third among the States in both quantity and value of output of salt in 1915. The quantity produced was 5,880,243 barrels (823,234 tons), valued at $1,462,192, an increase of 379,407 barrels (55,651 tons) in quantity and of $141,638 in value, compared with 1914.

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The salt came from two districts, one in northeastern and the other in southeastern Ohio. In northeastern Ohio the salt was produced at Cleveland, Cuyahoga County; Wadsworth, Medina County; Akron, Summit County; and Rittman, Wayne County. Brine is pumped at Fairport Harbor, Lake County, and at Barberton, Summit County, and is used directly in the manufacture of soda. The brine utilized in making salt and soda is obtained by allowing water to come into contact with beds of salt. In southeastern Ohio, Pomeroy, Meigs County, is the center of the industry, and in addition to salt, bromine and calcium chlorides are also produced from the natural brines.

OKLAHOMA.

The small production of salt in Oklahoma in 1915 came from Harmon County. The salt plains of Harmon County are located in small canyons in the gypsum hills south of Elm Fork of Red River, about 5 miles east of the Texas border and 1½ miles south of the north line of the county. The plains are known locally as the Chaney or Salton salt plain and the Kiser salt plain. They are both small, neither covering an area of more than an acre, and they are not more than a mile apart. The salt is contained in spring water that issues from shallow beds occurring below gypsum. Springs also boil up from the level floor of the plains. A local industry has been carried on for many years in this region at the old Kiser Salt Works. The springs farther west, and now known as the Salton salt beds have been worked for the last five years. Salt for stock is produced at both places.

TEXAS.

The production of salt in Texas in 1915 was 444,978 barrels (62,297 tons), valued at $345,944, an increase of 109,999 barrels (15,400 tons) in quantity and of $94,451 in value, compared with 1914. The major production came as usual from 6½ miles west of Palestine, Anderson County, and from Grand Saline, Van Zandt County. Some solar salt was reported from Crane County and from Saltburg (Colorado post office), Mitchell County.

UTAH.

The production of salt in Utah in 1915 amounted to 394,850 barrels (55,279 tons), valued at $266,334, an increase of 19,393 barrels (2,715 tons) in quantity and of $34,822 in value, compared with 1914. The salt produced in Utah came chiefly from the shores of Great Salt Lake, at Garfield and Saltair, and from Salduro, Tooele County. Rock salt was produced in the Sevier Valley near Redmond, in Sevier and Sanpete counties. Though the salt is obtained in the form of rock salt and is sold in part as such, some of it is dissolved, recrystallized, and retailed in the refined form as table and dairy and packers' salt.

VIRGINIA.

Deposits of salt and gypsum occur in Washington and Smyth counties, Va., in a belt of country 20 miles long, running northeast from the village of Plasterco. The Saltville branch of the Norfolk &

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Western Railway, which joins the main line at Glade Spring, renders the region accessible. The rocks in which the deposits occur are of Mississippian age.

Two gypsum and one salt or alkali works are in operation in the region. Since 1895, when the Mathieson Alkali Works came into control of the property, the brine has been converted into soda products. Over 50 wells have been drilled near Saltville and Plasterco, about 25 of which are now in operation. They range in depth from a few hundred to 2,280 feet, the average depth being about 1,000 feet. The shallower wells are dry and have to be flushed with water through the outer casing. The deeper wells are wet, and brine flows into them as fast as it is pumped out.

WEST VIRGINIA.

The quantity of salt produced in West Virginia in 1915 was 232,239 barrels (32,513 tons), valued at $115,143, an increase of 86,810 barrels (12,153 tons) in quantity and of $37,107 in value. The salt was reported from Malden, Kanawha County, and from Mason and Hartford, Mason County. Bromine and calcium chloride are also made in connection with salt at these localities.

HAWAII.

One of the minor products of the Hawaiian Islands is salt, the output of which in 1915 was 2,400 tons, valued at $8 per ton. Most of the salt produced in the islands is the output of the Honolulu Salt Co., whose product is coarse salt made entirely by solar evaporation. The company operates at Puuloa, Kalihi, and Waikiki, on the island of Oahu, and at Mahukona, on the west coast of Hawaii.

PORTO RICO.

Both the quantity and the value of the salt produced in Porto Rico in 1915 were greater than in 1914. The salt is made by solar evaporation at Barrio de Boqueron, Cabo Rojo, and at Salina de Cabo Rojo, San Juan. Competing imports from Curaçao have tended to retard the production of salt in Porto Rico, because, it is said, both wages and living expenses are less in Curaçao than in Porto Rico.

BROMINE.

PRODUCTION.

Bromine is made in connection with the manufacture of salt at Mount Pleasant, Isabella County; Midland, Midland County, near Saginaw, and at St. Charles, Saginaw County, and Bay City, Bay County, Mich.; in the Ohio Valley at Pomeroy, Meigs County; at Mason and Hartford, Mason County, and in the Kanawha Valley at Malden, Kanawha County, W. Va. In Michigan the bromine has been marketed in the form of fine chemicals, but the great increase in demand, brought on by the war in Europe, has caused a great deal of the bromine to be marketed as such. Along Ohio River, where there is cheap transportation by rail and water and cheap coal and gas, and where salt and bromine occur naturally, bromine has been produced for export for many years to be made into fine chemicals.

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Here is an opportunity for the American chemist which should not be neglected.

Bromine marketed, 1880–1915.

Year.	Quantity (pounds)	Value.	Year.	Quantity (pounds)	Value.	Year.	Quantity (pounds)	Value.
1880	404,690	$114,752	1894	379,444	$102,450	1905	1,192,758	$178,914
1883	301,100	72,264	1895	517,421	134,343	1906	938,128	165,204
1884	281,100	67,464	1896	546,580	144,501	1907	1,000,827	195,281
1885	310,000	89,900	1897	487,149	129,094	1908	760,023	73,783
1886	428,334	141,350	1898	486,979	126,614	1909	569,725	57,600
1887	199,087	61,717	1899	433,004	108,251	1910	245,437	31,684
1888	307,386	95,290	1900	521,444	140,790	1911	651,541	110,902
1889	418,891	125,667	1901	552,043	154,572	1912	647,300	145,805
1890	387,847	104,719	1902	513,893	128,472	1913	572,400	115,436
1891	343,000	54,880	1903	598,500	167,580	1914	576,991	203,094
1892	379,480	64,502	1904	897,100	269,130	1915	855,357	856,307
1893	348,399	104,520						

The great increase in the output and especially in the value of bromine shown in the table for 1915 is significant. The price of bromine during the first five months of 1916 ranged from $4.75 to $6.50 per pound in New York, the result in part at least of the unprecedented demand from abroad, where it is said to be used in asphyxiating gases. The comparatively low price per pound indicated in the table is due to the fact that considerable bromine was sold at prices specified in contracts made before the demand increased and to the further fact that the figures indicate prices at the point of production, and hence do not include the cost of freight.

CALCIUM CHLORIDE.

PRODUCTION.

Calcium chloride is made from natural brines in the Saginaw Valley in Michigan, in the Ohio Valley in Ohio and West Virginia, and in the Kanawha Valley, W. Va. Thus practically every constituent in these brines is saved and turned into profit. Calcium chloride is manufactured at Mount Pleasant and Saginaw, Mich.; Pomeroy, Ohio; and Mason, Hartford, and Malden, W. Va.

Statistics of production of calcium chloride from natural brines have been collected by the Geological Survey since 1909. These figures given in the table below do not include the output obtained in the manufacture of soda, as such calcium chloride is not an original constituent of the brine. Large quantities of calcium chloride formerly wasted in the manufacture of soda, the source of which is different from that considered in this report, are now being used in part, and it is to be hoped that new uses for what is still wasted may soon be found.

Calcium chloride sold in the United States, 1910–1915.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	10,971	$74,713	1913	19,611	$130,030
1911	14,606	91,215	1914	19,403	121,766
1912	18,550	117,272	1915	20,535	130,830

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MICA.

By WALDEMAR T. SCHALLER.

CONDITION OF THE INDUSTRY.

High prices were paid for mica in 1915 as a result of the European war, and in consequence the mica industry was in a prosperous condition, as is clearly indicated by the table on page 284 showing the total production since 1880. The quantity of sheet mica, rough trimmed and cut, produced in 1915 was smaller than in any of the 12 preceding years, but the value is the highest recorded. The total value of all mica, sheet and scrap, produced in 1915 was $428,769, an amount exceeded only in 1913, when the value was $436,060. In no other year was the value so much as $400,000. The average price of sheet mica, rough trimmed and cut, was the highest in the last 13 years, as the following table shows:

Average price per pound of sheet mica, 1902–1915.

1903	$0.19	1908	$0.24	1913	$0.21
1904	.16	1909	.13	1914	.50
1905	.17	1910	.11	1915	.68
1906	.18	1911	.17		
1907	.33	1912	.33		

The statistics of production in 1915 refer only to mica that is used as such in the trade and that remains mica in its final application. The only mica thus included is muscovite. Phlogopite is extensively used in industrial work, but none is mined in the United States. Other micas were mined in 1915, notably roscoelite, which is similar to muscovite in composition, except that vanadium replaces some of the aluminum. Roscoelite is of value not because of its physical properties, but because it is used chemically as a source of vanadium; and it is therefore discussed in the chapter on vanadium in Mineral Resources. Lepidolite, a mica containing lithium and fluorine in larger proportion than most other micas, has in past years been utilized as a source of lithium salts; but in 1915 the output was all used in glass making. A bronze-colored material used for decoration is obtained by heating an altered hydrated biotite. Clinochlore, a micaceous mineral, a member of the chlorite family, is also used commercially, chiefly as a filling for hard-rubber goods. The production of lepidolite, biotite, and clinochlore is not included in the figures showing the output of mica but is given under the heading "Minerals allied to mica," on pages 289–290.

COMMERCIAL PROPERTIES OF MICA.

The chief physical properties that give value to mica are its cleavage, flexibility, elasticity, transparency, lack of color in thin sheets, nonconductivity of heat and electricity, and resistance to decomposi-

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tion. These properties make mica indispensable in the electrical trade, which consumes most of it. Only one producer reported a greater output of stove mica than of electrical mica. The output of electrical mica of the other producers shows percentages ranging from 76 to 100 of their total output of cut sheet mica. Cut stove mica brings a much higher price—from $1.50 to $3.33 a pound; the corresponding price for cut electrical mica is 9 cents to 74 cents a pound. Mica is sometimes called isinglass when it is used in glazing, but true isinglass, although resembling mica in some of its properties, is a gelatinous substance made of the air bladders of certain fish, is soluble in boiling water, and burns readily, whereas mica is not combustible.

The brilliancy of small scales of mica has made them valuable in the decorative arts, and hence ground mica is used extensively for the decoration of wall paper, to which it adds luster and brightness.

The crystals of mica are rough blocks, hexagonal if complete, or the mineral may occur in sheets of no regular shape, though perhaps one or two of the six sides of the crystal may be seen. The black, brown, or red inclusions of iron oxide—the "specks"—are in some crystals arrayed in straight lines, which are either parallel to or bisect the edges of the crystal.

The rough blocks or crystals of mica, as mined, must be freed from adhering rock and split into thin sheets, which are rough trimmed with a knife, and the mica is then graded for size and quality. The rough blocks, as obtained from the mines, yield only about 10 per cent of finished trimmed sheet mica ready for use in the electrical and glazing trades. The remainder is scrap mica, suitable only for grinding. A few crystals have been reported to yield as high as 80 per cent of trimmed sheets, but this yield is unusually large.

The average yield of cut sheet mica, ready for the trade, from run-of-mine mica, as deduced from the reports of the producers, is 17 per cent for New Hampshire, 10 per cent for South Dakota, and about 9 per cent for Virginia and for North Carolina. The average yield for the United States, as calculated from the reports of 15 producers, is about 11 per cent, the limits being 2 and 33 per cent, respectively; the average for the United States, as calculated from the total production, is 7 per cent. The Arizona State Bureau of Mines has published a bulletin[1] on mica in which is given a "flow sheet" from a New Hampshire mica mine, showing the quantities and values of mica in each 1,000 pounds mined used for different purposes. The yield of sheet mica, about 30 per cent, is much higher than the average for any single State.

The thin sheets of mica used in the trade are colorless. Muscovite in thin sheets is called clear or white mica; in sheets sufficiently thick to show a decided color, usually more than one-sixteenth of an inch, it is amber, yellow, green, brownish red or "rum," red or "ruby," smoky, gray, or brown. Phlogopite in thin sheets is generally yellowish or brownish; in thicker sheets it is yellow, brown, black, or coppery. Biotite is black and dark brown or green in thin sheets. "Specked" mica contains inclusions of dark minerals, mostly some form of iron oxide, which may be so abundant that the mica is called

[1] Cullin, F. L., jr., Mica: Arizona State Bur. Mines Bull. 16, Mineral Technology ser. No. 8, 1915–16.

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"black mica," even if the mica itself is nearly colorless. Although specked mica is inferior to clear mica for electrical insulation, it is satisfactory if used with discretion and in electrical apparatus in which the currents have only a low voltage. It has been used with satisfactory results where the currents measured less than 1,000 volts. The specks are extremely thin scales of iron oxide, which lie between the laminæ of the mica but do not penetrate the sheets and so do not greatly affect the insulating power of the mica. "Clay-stained" mica owes its unsightly appearance to the introduction of clay and dirt between the sheets. This clay may not penetrate the whole crystal or sheet and may be easily removed by splitting off the stained layer. Good mica should split to perfectly even, smooth sheets, but peculiar irregularities in crystal structure are rather common to all mica. Tangle-sheet mica will not split evenly, and ruled mica, to which the names ribbon, wedge, A, hair-lined, fish-bone, or herring-bone are applied, has but little value as sheet mica.

OCCURRENCE.

Mica is widespread in its occurrence and is one of the commonest minerals. It is found in many igneous rocks, in a large proportion of metamorphic rocks—as, for example, mica schist—and in many secondary rocks such as sandstone and shale. The natural processes of change which turn the feldspars of rocks into clay have but little effect on mica, which finds its way into the resulting sands and clays that are later consolidated into the sedimentary rocks—sandstones and shales. These bright, shining specks or scales of mica are often mistaken for gold or other valuable mineral, particularly if the original mica was biotite instead of muscovite, for much of the iron-bearing biotite assumes a golden-yellow or brownish color in its weathered forms.

The mica scales in the sandstones and shales are too small and too scarce to be of any commercial value. Many of the metamorphic rocks, such as the schists and gneisses, contain more mica than sandstone or shale, but the small size of the mica scales and the presence in abundance of quartz and other minerals has so far rendered such occurrences of doubtful value. Some mica schists or sericite schists (fine, shreddy muscovite is called sericite) that consist almost entirely of mica, with practically no quartz or other harder mineral, may be valuable. Quartz is so commonly associated with mica in metamorphic rocks that it seems doubtful whether any large bodies of sericite schist can be found that would be workable at a profit if mica should be the only product obtained. Sericite, as is noted by Rogers,[1] may be a low temperature modification of muscovite; it may be a dimorphous form and therefore a distinct species.

A small quantity of fresh pegmatite rock containing mica in scales larger than those of the metamorphic schists but still too small to be used otherwise than as scrap for grinding has been crushed and the mica extracted from it. Mica has also been concentrated from the residue of a clay plant that worked an altered pegmatite rock for its clay content, which was a product of decomposition of feldspar.

Mica forms about 4 per cent of all igneous rocks, but sheet muscovite can be extracted commercially only from pegmatite. Pegma-

[1] Rogers, A. F., Sericite, a low temperature hydrothermal mineral: Econ. Geology, vol. 11, p. 118, 1916.

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tite is a rock similar to granite in chemical and mineral composition, but has a more variable and coarser texture. It occurs in irregular-shaped masses, streaks, lenses, or sheets called veins or dikes, which vary many feet in both length and thickness. The surrounding rock is generally geologically very old, much of it changed to a gneiss or schist, the directions of whose structural features have had a large influence on the direction of the pegmatite sheet. In some mines the muscovite is concentrated in one or more well-defined layers or bands near the edges of the pegmatite, but more commonly it is scattered unevenly through the pegmatite, or the mica crystals may occur as individuals or in clusters scattered irregularly through the rock.

The occurrence of mica in sheets several feet in width makes it particularly valuable. Individual crystals 2 feet wide are not rare, and crystals 1 foot wide are common. A crystal from New Hampshire was 28 inches wide and 4 feet 2 inches long; another fine crystal was 2 feet wide and 2 feet long. Two crystals from North Carolina measured, respectively, 33 by 29 by 32½ inches and 33½ by 29½ by 17½ inches. Muscovite crystals 10 feet across the cleavage plane are reported to have been found in the Nellore district, India. Phlogopite has been reported from the Canadian mines in crystals 5 feet wide and nearly 10 feet long, weighing about a ton and a half. Mr. M. F. Westover, of the General Electric Co., states that one crystal measured 119 inches in width. It is of interest to record the gift of a section of a crystal of phlogopite from a mine near Sydenham, Ontario, Canada, to the United States National Museum, where the specimen is on public exhibition. The gift was made by Mr. Westover, through the United States Geological Survey. The section, which is somewhat less than an inch thick, measures 47 by 35 inches across the cleavage face. Crystals so large are very exceptional, few exceed 2 feet across the cleavage faces.

The United States, Canada, and India are large producers of mica, and it is also obtained from German East Africa, Brazil, South Africa, Ceylon, Norway, China, Japan, Argentina, and South Australia. Deposits that may be of value have been reported from several other countries.

Mica deposits of probable value have been found in about half the States of the United States. The principal producing States have been North Carolina, New Hampshire, South Dakota, Idaho, New Mexico, Colorado, Virginia, South Carolina, Alabama, and Georgia.

The possibility of the occurrence of mica deposits in the United States has been deduced by Sterrett[1] to be as follows:

> A study of the geologic map of North America shows the possibility of the occurrence of mica deposits in the following regions of the United States: In the eastern Appalachian region from Alabama to New York State and in the New England States; in northern Wisconsin, Michigan, and Minnesota, and in the region including corners of Minnesota and Iowa and part of South Dakota; in the Black Hills of South Dakota; in the Rocky Mountain region from New Mexico to Montana; and in many smaller more or less isolated areas in nearly all the Western States from Texas to California and Washington. The same map shows large areas in which younger sedimentary rocks cover the older crystalline rocks beneath a mantle ranging from hundreds to thousands of feet in thickness and in which, accordingly, mica deposits are not to be expected.

[1] Sterrett, D. B., Mica: U. S. Geol. Survey Mineral Resources, 1914, pt. 2, p. 68, 1915.

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USES.

The uses to which mica is put are very different and depend on its form—whether in sheets or in powder. Sheet mica is used in the electrical industry, for glazing, and to some extent for other purposes. Ground mica is used chiefly in the decorative trades and in insulating coverings.

Sheet mica finds its greatest use in the electrical industry, where an insulating, noninflammable material is necessary. It is used in sheets and as washers and disks in dynamo-electric machinery, electric-light sockets, spark plugs, insulators, guards in rheostats, fuse boxes, and telephones. Flexible cloth and tape, covered with mica, find varied uses in electrical apparatus. Sheet mica is used for glazing the fronts of stoves and for making lamp chimneys and lamp shades. It is also used in spectacles, automobile shields, phonograph diaphragms, and in windows where glass would be broken.

An apparently new use for mica sheets has been developed by George Palmer,[1] 47 Gerrard Street, London, W., primarily

for the use of cinematograph showmen, but of application also in any branch of lantern projection. Mica, as everybody knows, is a material which will withstand a certain degree of heat, although constant exposure to a fairly high temperature will lead to its disintegration in time. It is, however, easily scratched, a defect which Mr. Palmer has successfully overcome by a special process. Thus he is able to offer lantern transparencies which are not only unbreakable, but are fully capable of withstanding such damage in the way of scratching or exposure to heat as they are likely to get under the most trying conditions of arc projection and general handling. We have examined some of these slides and have found it impossible to scratch the surface short of using a sharp cutting instrument. The photographic image itself is one obtained by a firing process, and is therefore as permanent as the material which supports it. At present the slides are issued only in sepia—a fine rich sepia which projects excellently upon the screen. Each transparency is mounted in a metal frame which holds the mica flat, a set of such framed transparencies being very much less in weight than a corresponding set made in the usual way on glass with a cover plate of the same material. Mr. Palmer, however, supplies the special mica for such purposes as the making of cover plates for slides, so that those employing the ordinary glass lantern plates can secure considerable reduction in weight by substituting a mica for a glass cover plate without any disadvantage that we can see. For other photographic purposes a light transparent material with the physical properties of the prepared mica should frequently be of service.

Ground mica is used for decoration in wall paper, to which it gives luster and brightness; in fancy paints, ornamental tiles, concrete, rubber goods, pipe and boiler coverings, insulating compounds, fireproof paints and coverings, patent roofing material, molded mica (ground mica mixed with shellac), and calico printing; as absorbent for nitroglycerine in the manufacture of "mica powder," in tempering steel, and to a large extent as a lubricant for wooden bearings, or, mixed with oil, as a lubricant for metal bearings. Tar and other roofing papers are coated with coarsely ground mica to prevent sticking when they are rolled for shipment. A possible value of ground mica as a chemical source of potash salts is indicated in a recent report by B. S. Butler,[2] who lists a large number of analyses that represent the chemical composition of the tailings from copper ores, many of which are relatively high in potassium contained in muscovite.

[1] British Jour. Photography, vol. 63, No. 2928, p. 350, June 16, 1916.
[2] Butler, B. S., Potash in certain copper and gold ores, with a note on muscovite by George Steiger: U. S. Geol. Bull. 620, pp. 227–235, 1916.

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In the same publication Mr. Steiger[1] contributes a note on muscovite, from which the following is taken:

> Finely ground [and ignited] muscovite was intimately mixed with ammonium chloride in a mortar, and the material was then put into glass tubes, sealed, and heated to 350° C. in a bomb furnace. The tubes were next opened and their contents were leached with hot water and washed until the wash water gave no test for chlorine. * * * [The results indicated that practically all the potash] was found in the leach water, showing that by first fusing [igniting] the muscovite and then treating it with ammonium chloride its potassium was entirely converted into the soluble form. * * * More than 25 per cent of the potassium present may be converted into the soluble form by the treatment with ammonium chloride alone.
>
> Some experiments were also made to determine to what extent potassium might be extracted from muscovite by treatment with hydrochloric acid. The results stated below show that by a very superficial treatment with hydrochloric acid approximately one-third of the potassium may be extracted.

	Per cent K_2O.
Boiled 5 minutes with 1–1 HCl	3.36
Boiled 5 minutes with 1–10 HCl	2.94
Boiled 30 minutes with 1–1 HCl	4.24
Boiled 30 minutes with 1–50 HCl	3.21

Several trade names have been given to mica products that are briefly described below.

Micanite is a term applied by the Mica Insulator Co., Schenectady, N. Y., to a mica board made from many small, thin sheets of mica, which are fitted together and built up by successive layers that are cemented with shellac and then subjected to pressure under heat to dry out the shellac. Large sheets thus made are suitable for many electrical purposes.

Zilberglimmer, the German for silvery mica, is muscovite which has been heated to a sufficiently high temperature to make it softer and opaque and silvery in appearance. It is also known as annealed mica, and finds a use in certain parts of electrical apparatus.

Micarta is an artificial mica product developed by the Westinghouse Electric & Manufacturing Co., of Pittsburgh, Pa., and is intended to take the place of hard fiber, glass, porcelain, hard rubber, built-up mica board, rawhide, molded compounds for use in commutators, bushings, brush-holder insulation, noiseless gear blanks, conduits for wiring, spools for spark coil and magnet windings, wireless-coil separators, and water-meter disks. Micarta is a tan-colored, hard, homogeneous material that can be sawed, milled, turned, and threaded. Thin sheets can be punched, and it is claimed that it will not warp, expand, or shrink beyond very small limits. Two grades of micarta are made. One, known as bakelite micarta, is infusible and will resist heat to a point at which carbonization of some of the ingredients takes place. It is insoluble in nearly all ordinary solvents, such as alcohol, benzine, turpentine, and weak acid and alkali solutions.

Macamima, prepared by the Crawford Mica Co., of Crawford, Nebr., is a coarsely ground mica used in the manufacture of concrete facing material; mixed with other minerals it is used to give the effect of natural rock, and it may be used for different decorative purposes.

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[1] Butler, B. S., Potash in certain copper and gold ores, with a note on muscovite by George Steiger: U. S. Geol. Survey Bull. 620, pp. 235–236, 1916.

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Micolith, prepared by the Texas Mica Co., of Pecos, Tex., is another similar product used to give the effects of natural rock to concrete facings.

Tungash, as the Denver Mining & Manufacturing Co., of Denver, Colo., call their product, is a bronze-colored, metallic-looking material of value for decoration. The crude biotite mica, altered and hydrated, has a dull greenish-black appearance when mixed. On being heated it expands to a light product, which has a rich golden-bronze color and a decidedly metallic luster. The production of this biotite mica has not been included in that of mica, but is given on pages 289–290 under the heading "Minerals allied to mica." The treatment by heat necessarily changes the chemical composition of the product, which is no longer that of the original biotite mica.

PRODUCTION.

The total value of the mica (muscovite) produced in 1915 was $428,769, the highest in any year since 1879 except 1913, when the value was $436,060. The value of the sheet mica produced in 1915 was the highest since 1879, but the production of all kinds of mica, or of either sheet or scrap mica alone, has been exceeded in several previous years. The production of all kinds of mica in 1915 (8,471,821 pounds) was exceeded by the production in 1909, 1910, 1911, and 1913, and was not much greater than that in 1907, 1912, or 1914. In fact the quantity of sheet mica produced (553,821 pounds) was the smallest since 1902. The fact that, with a relatively small production, a maximum value was recorded, shows that prices in 1915 were higher than in previous years.

The production came from 10 States—North Carolina, New Hampshire, Idaho, South Dakota, Virginia, Alabama, New York, Connecticut, Georgia, South Carolina—named in the order of the value of their output. New York reported no production in 1914, whereas Maryland and Maine, which produced mica in 1914, reported no production in 1915. New Mexico reported a little mica taken out but not sold, and Alaska reported several tons of scrap mica, also not sold. Colorado produced biotite mica and California produced lepidolite mica in 1915, but their production is put under the heading "Minerals allied to mica."

The percentage of production in the different States is shown in the following table:

Percentage of production of mica in 1915 by States.

State.	Sheet.		Scrap.	
	Quantity (pounds).	Value.	Quantity (tons).	Value.
North Carolina	51	70	72	67
New Hampshire	17	16	13	15
South Dakota	5	2	5	5
Virginia	2	2	2	2
Idaho, Alabama, New York, Connecticut, Georgia, South Carolina	[a] 25	[a] 10	[a] 8	[a] 11
	100	100	100	100

[a] No single State except Idaho over 2 per cent.

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The total production of mica in North Carolina in 1915 was valued at $300,593, as compared with $195,270 in 1914. The production reported consisted of 281,074 pounds of sheet mica, valued at $266,650, and 2,840 tons of scrap mica, valued at $33,943. The production of sheet mica in 1914 amounted to 274,121 pounds, valued at $171,370, and of scrap mica to 1,789 tons, valued at $23,900. A large percentage of the mica from North Carolina is reported as cut mica, ready for the trade, and therefore is given a much higher value than the uncut or run-of-mine mica reported from other States.

The production in New Hampshire in 1915 was valued at $66,971, as compared with $47,837 in 1914. The production reported consisted of 96,685 pounds of sheet mica, valued at $59,414, and of 516 tons of scrap mica, valued at $7,557. The production of mica in 1914 amounted to 133,556 pounds of sheet mica, valued at $39,588, and of 600 tons of scrap mica, valued at $8,249.

Mica produced in the United States, 1880–1915.

Year.	Rough-trimmed and cut mica.		Scrap mica.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Short tons.*		
1880	81,669	$127,825	.....	.....	$127,825
1881	100,000	250,000	.....	.....	250,000
1882	100,000	250,000	.....	.....	250,000
1883	114,000	285,000	.....	.....	285,000
1884	147,410	368,525	.....	.....	368,525
1885	92,000	161,000	.....	.....	161,000
1886	40,000	70,000	1,000	$10,000	80,000
1887	70,000	142,250	2,000	15,000	157,250
1888	48,000	70,000	.....	.....	70,000
1889	49,500	50,000	196	2,450	52,450
1890	60,000	75,000	496	6,200	81,200
1891	75,000	100,000	.....	.....	100,000
1892	75,000	100,000	.....	.....	100,000
1893	51,111	80,629	156	8,300	88,929
1894	35,943	43,793	191	8,595	52,388
1895	84,408	50,381	148	5,450	55,831
1896	49,156	65,441	222	1,750	67,191
1897	82,676	80,774	740	14,452	95,226
1898	129,520	103,534	3,999	27,564	131,098
1899	108,570	70,587	1,505	30,878	101,465
1900	456,283	92,758	5,497	55,202	147,960
1901	360,060	98,859	2,171	19,719	118,578
1902	373,266	83,843	1,400	35,006	118,849
1903	619,600	118,088	1,659	25,040	143,128
1904	668,358	109,462	1,096	10,854	120,316
1905	924,875	160,732	1,126	17,856	178,588
1906	1,423,100	252,248	1,489	22,742	274,990
1907	1,060,182	349,311	3,025	42,800	392,111
1908	972,964	234,021	2,417	33,904	267,925
1909	1,809,582	234,482	4,090	46,047	280,529
1910	2,476,190	283,832	4,065	53,265	337,097
1911	1,887,201	310,254	3,512	45,550	355,804
1912	845,483	282,823	3,226	49,073	331,896
1913	1,700,677	353,517	5,322	82,543	436,060
1914	556,933	278,540	3,730	51,416	329,956
1915	553,821	378,259	3,959	50,510	428,769

This table has been compiled from the figures reported by the producers. The value therefore includes that of the cut mica ready for the trade, the uncut mica, and the run-of-mine mica. The run-of-mine mica is sold either in bulk at so much per ton or on contract at a fixed price per ton. The prices paid represent the value of the mica as it is taken from the mine and not the value of the finished cut mica ready for the trade. The finished cut mica brings a much

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higher price, as it is ready to be used in the industries and has had a considerable amount of money spent on it. It is obviously incorrect to add together the value of mica of two greatly different classes, yet this procedure is the only one that can at present be followed. The total production for the United States in 1915 of cut sheet mica was 273,684 pounds, valued at $275,367, an average price of $1.01 a pound. The total production of uncut sheet mica, which includes an estimated percentage of the sheet yield of run-of-mine mica, was 280,137 pounds, valued at $102,892, or an average price of only $0.37 a pound. Yet this uncut sheet mica needs only to be cut in order to have its value nearly trebled.

The figures so far given to show the production of mica in 1915 cover only muscovite sold. In addition, some mica was mined but not sold, the quantity and estimated value of which are given below. The sheet mica mined in 1915 but not sold amounted to 7,960 pounds—about 1 per cent of the sheet mica sold—and its estimated value was $4,080; the scrap mica mined but not sold amounted to 129 tons—about 3 per cent of the scrap mica sold—and had an estimated value of $1,837. The estimated value of all the mica mined but not sold is about 1 per cent of the value of all mica mined and sold.

Mica mined but not sold in 1915.

State.	Sheet.		Scrap.	
	Quantity (pounds).	Estimated value.	Quantity (short tons).	Estimated value.
Alabama	3,750	$2,748	2	$34
New Mexico	1,300	450	30	500
Georgia	1,500	270	12	190
Connecticut	300	189	1	12
New Hampshire	400	180	22	220
Virginia	535	168	45½	683
North Carolina	175	75	½	6
Alaska			9	108
South Carolina			7	84
	7,960	4,080	129	1,837

PRICES.

The first table in this report (p. 277) compares the average price per pound of sheet mica in 1915 ($0.68) with the smaller average prices in previous years. The higher prices prevailing in 1915 and holding in the first part of 1916 are due to unusual conditions, which result in part from the difficulties of importing mica. The report of the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, on the imports of mica for 1915 show, however, that in both quantity and value the imports of mica for 1915 exceeded those for 1914. As imports of mica are also being received in 1916, it is evident that the present high price of mica is somewhat artificial and that there is no guaranty of permanency. It may be an incentive for new development work, but it should be so taken with a good deal of caution.

The following table gives the average prices paid in the South for rough-trimmed mica of good quality sorted to cut the sizes indicated.

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Average prices per pound paid in the South for rough-trimmed mica of good quality.

Size (in inches).	1913	1914 (estimated).	1915, first half.	1915, second half.	1916, first half.
Punch	$0.035	$0.03	$0.04	$0.04	$0.05
1½ by 2	.12	.10	.12	.25	.25
2 by 2	.30	.25	.25	.50	.50
2 by 3	.70	.65	.60	.80	.85
3 by 3	1.15	1.00	.95	1.20	1.30
3 by 4	1.35	1.20	1.10	1.50	1.60
3 by 5	1.70	1.50	1.30	1.75	1.95
4 by 6	2.25	2.00	1.90	2.50	2.85
6 by 6	3.00	2.70	2.60	3.00	3.95
6 by 8	4.00	3.60	3.60	3.50	5.20
8 by 10	6.00	5.40	5.20	5.00	7.90

The table shows that the increase of prices in 1915, and even for the first half of 1916, is not very great, and that the greatest increase holds only for the smaller sizes. These prices are only averages; the actual price obtained by the miner depends so much on the condition and quality of his mica that great caution must be exercised in applying these prices to any lot of mica. The figures represent only those paid for good mica of the first and second quality. Mica of poorer grades is worth much less, as is shown by the following table, which gives the average prices, according to quality, paid in the South in the second half of 1915. As the table shows, size is the principal basis for grading rough-trimmed sheet mica after it is sorted for quality. The prices are those offered per pound for rough-trimmed mica, sorted to cut the sizes and qualities indicated.

Grades and prices per pound of mica, 1915.

Grade.	Size (in square inches).	Approximate corresponding sizes used as basis of purchase in the South.	Price according to quality.		
			No. 1 and No. 2 quality.	Spotted or slightly clay stained.	Black "specked," heavily clay stained.
Extra special	48 and up	8 by 10	$5.00	$4.00	$3.00
Special	36 to 48	6 by 8	3.50	3.00	2.50
1	24 to 36	6 by 6	3.00	2.50	2.00
2	14 to 24	4 by 6	2.50	2.00	1.70
		3 by 5	1.75	1.50	1.35
3	9 to 14	3 by 4	1.50	1.25	1.15
4	6 to 9	3 by 3	1.20	1.00	.95
		2 by 3	.80	.65	.45
5	3 to 6	2 by 2	.50	.30	.25
6	— to 3	1½ by 2	.25	.15	.....
		Punch[a]	.04	.04	.04

[a] Punch mica will yield disks 1½ inches in diameter.

A comparison of these prices with those for 1913 and 1914 shows that the greatest increase has been made in the prices of mica of the smaller sizes and that the increase in the value of clay-stained and black-specked mica has been greater than that in the value of mica of the first and second qualities.

The average price of sheet mica, including cut and uncut, in the United States in 1915, as deduced from the total production, was 68 cents a pound, as compared with 50 cents a pound in 1914 and 21 cents in 1913. The average price of sheet mica in North Carolina

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was 95 cents a pound, as compared with 63 cents a pound in 1914 and 29 cents in 1913; in New Hampshire the average price was 61 cents a pound, as compared with 30 cents a pound in 1914; in Idaho it was 25 cents a pound, as compared with 74 cents a pound in 1914; in Virginia it was 89 cents a pound, as compared with 81 cents a pound in 1914; in South Dakota, 32 cents, as compared with 5 cents a pound in 1914; in Alabama, 66 cents, as compared with 12 cents a pound in 1914. The variations in prices reported from different States in different years is largely due to the stage of manufacture in which the mica is reported. The mica sold in the rough at the mines necessarily includes a large proportion of scrap, and the prices are accordingly much lower than those for trimmed sheet mica reported by companies having trimming plants.

The average price of scrap mica in 1915, as deduced from the total production, was $12.76 a short ton, as compared with $13.78 a ton in 1914. In North Carolina the price was $11.95, as compared with $13.36 in 1914; in New Hampshire, $14.65, as compared with $13.74 in 1914; in Idaho, $16.99; in South Dakota, $15.05.

IMPORTS.

The imports for consumption of unmanufactured and trimmed sheet mica into the United States during 1915, as reported by the Bureau of Foreign and Domestic Commerce, Department of Commerce, were valued at $688,411, as compared with $625,396 in 1914. The reports show that 172 tons of ground mica, valued at $3,858, was imported in 1915, as compared with 202 tons, valued at $4,088, in 1914.

Unmanufactured mica imported into the United States, 1886–1897.

Year.	Value.	Year.	Value.
1886	$56,354	1892	$218,938
1887	49,085	1893	147,927
1888	57,541	1894	126,184
1889	97,351	1895	174,886
1890	207,375	1896	169,085
1891	95,242	1897	192,402

NOTE.—The imports in 1886–1890, inclusive, comprise waste or scrap mica.

Mica imported into the United States, 1898–1915.

Year.	Unmanufactured.		Cut or trimmed.		Ground.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
1898	877,930	$115,930	78,567	$34,152	.....	.....	956,497	$150,082
1899	1,709,839	233,446	67,293	42,538	.....	.....	1,777,132	275,984
1900	1,892,000	290,872	64,391	28,688	.....	.....	1,956,391	319,560
1901	1,598,722	299,065	78,843	35,989	.....	.....	1,677,565	335,054
1902	2,149,557	419,362	102,299	46,970	.....	.....	2,251,856	466,332
1903	1,355,375	288,783	67,680	29,186	.....	.....	1,423,055	317,969
1904	1,085,343	241,051	61,986	22,663	.....	.....	1,147,329	263,714
1905	1,506,382	352,475	88,188	51,281	.....	.....	1,594,570	403,756
1906	2,984,719	983,981	82,019	58,627	.....	.....	3,066,738	1,042,608
1907	2,226,460	848,098	112,230	77,161	.....	.....	2,338,690	925,259
1908	497,332	224,456	51,041	41,602	.....	.....	548,373	266,058
1909	1,678,482	533,218	168,169	85,595	.....	.....	1,846,651	618,813
1910	1,424,618	460,894	536,905	263,831	(a)	$1,298	1,961,523	725,823
1911	1,087,644	346,477	241,124	155,686	(a)	3,389	(a)	505,552
1912	1,900,500	649,236	88,632	99,737	b 343,824	b 6,611	2,332,956	755,584
1913	2,047,571	751,092	(a)	191,926	290,757	4,765	(a)	947,783
1914	360,888	168,591	(a)	456,805	404,848	4,088	(a)	629,484
1915	433,822	240,449	(a)	447,962	344,040	3,858	(a)	692,269

a Quantity not reported. b Figures cover only last six months of 1912.

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The average value of imported unmanufactured sheet mica, per pound, as calculated from the figures for 1915, was 47 cents, as compared with the average value of 37 cents for uncut sheet mica produced in the United States in 1915.

EXPORTS.

The exports of mica, chiefly to Canada, France, England, Belgium, and Germany, as reported, are as follows:

Mica exported from the United States, 1910–1915.

Year.	Unmanufactured.		Manufactured.	Total value.
	Quantity (pounds).	Value.	Value.	
1910				$20,543
1911	415,862	$15,649	$20,267	35,916
1912	356,601	14,936	25,876	40,812
1913	298,711	14,175	48,009	62,184
1914	467,451	23,145	27,751	50,896
1915	54,183	5,118	33,915	39,033

FOREIGN MICA.

CANADA.

The preliminary report on the mineral production of Canada gives the value of the mica produced in Canada in 1915 as $81,021. The manufactured mica exported to the United States, a total of 879,631 pounds, was valued at $236,124.

Consul F. S. S. Johnson,[1] of Kingston, Ontario, reports that—

> The price of fine-split amber mica, size 1 by 2, at present exported largely from the Ottawa district, and invoiced at from 20 to 35 cents per pound, is very low when the following facts are taken into consideration: Market value per pound of rough amber mica, 1 by 2, 12 cents; price paid for splitting 1 pound of amber mica, 12 cents; waste on 1 pound of fine amber mica, 4 cents; freight and handling from mine to factory, one-half cent; profit, 8 cents; total, 36½ cents.
>
> Most of the Ontario mica is mined in this consular district and taken to Ottawa to be trimmed and prepared for the American market. The fine-split amber mica is invoiced at this consulate at from 33 to 38 cents per pound.

BRAZIL.

Mica occurs in Brazil in workable quantities in the States of Goyaz, Bahia, and Minas Geraes, according to A. F. Calvert.[2] Although of good quality, the mica produced from Goyaz and Bahia is small in quantity, and little is known of its occurrence. The principal producing mines are pegmatite veins, lenses, or dikes, which occur in the metamorphic schists near the city of Santa Luzia de Carangola, on the borders of the States of Minas Geraes and Espirito Santo. The rocks are greatly decomposed and the pegmatite veins, from 20 inches to 10 feet wide, are largely composed of kaolin, in which the mica crystals are irregularly disseminated.

[1] Commerce Reports, Sept. 18, 1915.
[2] Calvert, A. F., Mineral resources of Minas Geraes (Brazil), p. 92, 1915.

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CHOSEN (KOREA).

The mica mines of Chosen (Korea) have been described by Shigetaro Kawasaki.[1] Both muscovite and phlogopite occur and have been known and used by the people of Chosen (Korea) for a long time. In 1909 mining for mica in Chosen (Korea) was undertaken by the Japanese. No figures of production or value are given in the English text.

CHINA.

Mica that seems to be of very good quality is reported by Consul E. C. Baker, of Chungking, China, to be found near Sungpan, in the Szechwan Province, West China, and one of the large Chinese firms there, which has a branch office in Shanghai, is prepared to export this product. The price, delivered at Shanghai, is between 9 and 10 cents United States currency per pound. About 15,000 pounds can be delivered every year.

INDIA.

The production of mica in India in 1914, the last year for which figures are available, is reported by Consul L. Memminger in the Commerce Reports to be 38,189 hundredweight. The production for 1913 is reported[2] as 45,422 hundredweight, as compared with 43,835 hundredweight in 1912. The value of the exports in 1913 amounted to £347,451 ($1,690,870), as compared with £284,290 ($1,383,497) in 1912.

The condition of the trade was fairly good during the first half of 1914, according to the report of the Chief Inspector of Mines in India for 1914, prices being slightly lower than in 1913, which was an exceptionally good year. The trade suffered severely from the beginning of the European war, and the output fell away in consequence. A large proportion of the demand for this mineral has hitherto come from Germany for use in its electrical industries. Certain firms with German interests, which were large purchasers of mica, have, it is stated, closed down. The export of mica to other countries in Europe was practically cut off, and the industry generally was much hampered by the abnormally high rates for ocean freights and insurance, brought about by the war. There was considerable difficulty with regard to shipments to America—to which country considerable consignments are sent direct in normal times—and the American market itself was dull. It is further reported that 4 mica mines in the Nellore district in Madras were relinquished and 40 were suspended, and the output during the last five months of the year (1914) was only 700 hundredweight, as compared with 4,700 hundredweight in the first seven months. The demand from London for slab mica kept the prices of this grade fairly firm, but the market for splittings, especially for those below the first grade, was much reduced.

MINERALS ALLIED TO MICA.

The minerals included under the heading "Minerals allied to mica" are as follows: (1) Biotite from Colorado, described in the earlier part of this report under "Tungash" and mined by the Denver

[1] Mica in Chosen: Chosen (Korea) Mineral Survey Bull., vol. 1, pt. 2, Seoul, 1916.
[2] India Geol. Survey Records, vol. 46, p. 180, 1915.

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Mining & Manufacturing Co., of Denver, Colo., which has been heated before being put on the market and thereby has its chemical character as a mica destroyed by partial loss of water and possibly other volatile constituents and by change in state of oxidation of the iron. The finished product is still micaceous in structure, but the new color and luster, acquired by the calcination, are probably of more value to the finished product than its micaceous structure. (2) Lepidolite from California, mined by the American Lithia & Chemical Co., 50 Church Street, New York, N. Y., which in former years has been utilized as a source of lithium salts, but which in 1915 was mined for use in making glass. (3) Clinochlore or chlorite schist, mined by the American Mica Co., 52 Broadway, New York, N. Y., at Canton, Ga., whose product ground to various meshes is used chiefly in composition of hard rubber and to a less extent in the manufacture of rubber tires, and of ready roofing, foundry facing, and lubricants.

The combined production of these three "allied minerals"—biotite, lepidolite, and chlorite schist—only the material actually sold being included for 1915, was 423 tons, valued at $7,685. In addition, there was mined but not sold a total of 1,020 tons having an estimated value of $19,410.

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SULPHUR, PYRITE, AND SULPHURIC ACID.

By W. C. PHALEN.[1]

SULPHUR.

THE DOMESTIC SULPHUR INDUSTRY.

Sulphur was produced in 1915 in Louisiana, Texas, Nevada, and Wyoming. The production in the two Western States was small, amounting to only slightly more than 1 per cent of the total output of the country. Thus more than 98 per cent came from the Union Sulphur Co., in Louisiana, and the Freeport Sulphur Co., in Texas. To avoid revealing confidential reports of output of these companies the figures for sulphur will not be tabulated, as they have heretofore been. They will be published in the table of mineral production of the United States and in the totals for the two States named, lumped, however, with other commodities, so that the value as sulphur will not be shown.

Though 1915 was a prosperous year in the sulphur industry, the output was not so great as in 1914. During the early part of the year business was somewhat dull, but it improved gradually as the year advanced. Slack conditions in the paper trade account in part for the falling off. The export trade in sulphur, as will be noted from a later statement in this report, was the lowest in some years, in spite of the partial paralysis of the sulphur trade in Italy incidental to the war in Europe. European inquiries for American sulphur have come from as far away as Greece.

Though the imports of foreign pyrite were not so great in 1915 as in 1914, they amounted to 964,634 long tons. In spite of these large imports and of a domestic output of pyrite of 394,124 long tons (an increase as compared with 1914), there has been, especially late in 1915 and early in 1916, an increasing call for sulphur from which to make sulphuric acid, owing to the great expansion in certain branches of chemical industry, and to the fear that in some way foreign shipments of pyrite might be curtailed. The high price received for the acid has made the use of the comparatively high-priced sulphur possible, but the use of sulphur has also certain obvious advantages owing to its purity and to the consequent fact that it leaves little or no residue. It is possible that in the manufacture of the highest grades of acid sulphur will continue to be used.

[1] The statistics in this report were prepared by Miss H. M. Gaylord.

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The stocks of sulphur on hand at the close of 1915 were the largest in the history of the industry.

IMPORTS.

The first table given below includes the usual classes of sulphur, together with grades not specifically defined. The second table shows that practically all our imports of sulphur in recent years have come from Japan and were entered at Pacific coast or Hawaiian ports.

Sulphur imported and entered for consumption in the United States, 1912–1915, by kinds.

Year.	Crude.		Flowers of sulphur.		Refined.		All other.[a]		Total.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1912	26,885	$494,778	1,311	$39,126	1,665	$40,933	66	$9,137	29,927	$583,974
1913	15,122	286,209	5,899	115,574	1,234	29,091	350	17,690	22,605	448,564
1914	23,610	398,984	621	17,214	1,800	47,568	104	14,171	26,135	477,937
1915	24,647	495,990	647	23,146	988	30,335	85	12,987	25,910	472,458

[a] Includes sulphur lac and other grades not otherwise provided for, but not pyrite.

Crude sulphur or brimstone imported into the United States, 1912–1915, by countries and by customs districts.

Countries whence exported and customs districts through which imported.	1912		1913		1914		1915	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
COUNTRY.								
Canada	.....	.....	98	$2,372	.....	.....	90	$2,000
United Kingdom	.....	.....	101	2,905	123	$3,312	1	23
Italy	2,348	$46,003	125	3,046	747	19,691	23	699
Japan	24,505	447,946	14,317	269,730	21,913	385,498	24,583	403,268
Other countries	32	829	.....	3	27	1,036	.....	.....
	26,885	494,778	14,641	278,056	22,810	409,537	24,647	405,990
CUSTOMS DISTRICT.								
Baltimore, Md	.....	.....	.....	.....	.....	.....	.....	.....
Boston and Charlestown, Mass	.....	.....	15	343	.....	.....	.....	.....
New York, N. Y	1,359	29,387	140	3,809	185	5,216	.....	.....
Los Angeles, Cal	850	13,757	1	42	1,320	26,493	750	12,171
San Francisco, Cal	15,984	280,010	5,110	86,146	12,460	218,842	11,862	186,743
Willamette and Portland, Oreg	7,646	149,612	6,802	128,709	7,164	124,907	7,287	119,534
Hawaii	1,000	20,916	523	8,923	1,182	22,669	960	17,529
All other	46	1,096	2,050	50,084	499	11,410	3,788	70,013
	26,885	494,778	14,641	278,056	22,810	409,537	24,647	405,990

EXPORTS.

In 1913 the United States exported 89,221 long tons of sulphur, valued at $1,599,761. In 1914 the exports were 98,163 long tons, valued at $1,807,324. In 1915 they declined greatly and were only 37,312 long tons, valued at $724,679. Adverse conditions in Europe and in the carrying trade are largely responsible for this slump, but

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the balance of trade in favor of the United States as between imports and exports of sulphur was 11,402 tons in quantity and $252,221 in value.

THE SULPHUR INDUSTRY IN TEXAS.

FREEPORT SULPHUR MINES.

The process of mining sulphur at Bryan Heights, near Freeport, Brazoria County, Tex., has been fully described in previous volumes of Mineral Resources. Since 1914 only such changes have been made as experience has suggested.

During 1915 systematic prospecting has been carried on. Drilling rigs have been continuously at work boring through the sulphur formation at regular intervals and testing the richness of the sulphur-bearing stratum at different points. Operating wells are located in the light of the information thus obtained.

The production of sulphur in 1915 was much larger than in 1914. The rapidity with which the product is being absorbed in the world's market and the satisfactory disclosures of the prospecting have influenced the Freeport Sulphur Co. again to increase greatly the capacity of the plant. Plants Nos. 1 and 2 adjoin and are on the south slope of the "Mound," as Bryan Heights is locally known. They have a combined capacity of 7,000 rated horsepower, operated under approximately 50 per cent overload, making over 10,000 developed horsepower.

Plant No. 3 is located about 3,500 feet nearly due north of the older plants and on the north slope of the Mound. It is being equipped with twelve 700 horsepower boilers, which have a total of 8,400 horsepower. This additional power more than doubles the combined capacity of the existing plants and gives a total for all plants of 15,400 rated horsepower, developing practically to 23,000 horsepower. The machinery equipment in the new plant will consist of 8 high-pressure heaters, 32 mine-water pumps (16 high pressure and 16 low pressure), 2 exhaust mine-water heaters, 2 high-pressure air compressors to furnish air for pumping liquefied sulphur from the wells, and 1 compressor for pumping boiler water from driven wells.

The plant will be housed in buildings of fireproof construction, nothing but concrete and steel being used. The stack will be of concrete, 157 feet high with a 16-foot inside diameter at the base. Independent reservoirs are being constructed to hold water for the new plant, divided as to boiler and mine waters, with a capacity of 50,000,000 gallons. These reservoirs will be connected with the existing reservoirs, making them mutually interdependent and able to transfer water in case of need from one to the other. Additional driven wells will provide water for the boiler supply, but the enormous quantity of water required for mine operations will come from the 3½-mile canal already constructed, which brings the water of Brazos River to the pumping station serving the reservoirs. Concrete flumes of large size will connect the reservoirs with the plant, through which the water will be brought to the suction of the pumps located within the plant. Additional electrically driven centrifugal pumps of great capacity will transfer the water from canals to reser-

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voirs. The total quantity of water required for all plants is approximately 7,000,000 gallons daily, all of which must be softened to prevent formation of scale. A lime treating plant for this purpose will be constructed so that the water going to the boilers and heaters will be practically free from scale-forming constituents. An elevated steel tower, with tank, is now being constructed to supply under heavy pressure the general requirements for water independently of those of the plant.

A second turbo-generator will furnish electric current for additional power and for light.

The consumption of fuel oil in all the plants will be approximately 3,500 barrels daily. Oil tank steamers will deliver this oil directly into large storage tanks located on the harbor front, from which it will be pumped to the mines. The transfer of the oil will be through an 8-inch pipe-line, 4½ miles in length. The fuel will be stored in two large steel oil tanks and a reserve adequate to cover a considerable period of operations will be kept. The wooden oil-storage tanks heretofore serving the older plants are being replaced by steel storage tanks of capacity equal to those provided for the new plant.

At least four sulphur wells may be pumped simultaneously in the combined plants, and the production from the Freeport sulphur mines, which are already taking a prominent place in supplying the world's sulphur requirements, should at least be doubled.

A narrow-gage railway, with motor cars and trucks, will connect the two plants, bringing machine shop, storeroom, and other adjuncts into prompt communication.

The shipping facilities are being increased, and new railroad tracks are being built to plants and bins. A most important part of this work is the construction, now well under way, of new docks on the harbor, from which steamers will be loaded on the western or mine side of the Brazos channel. Freeport Harbor is being developed in the lower reaches of the river near the head of the jetties, which extend well out into the Gulf of Mexico. The channel opposite the new docks will be dredged to the proper depth. In loading vessels, heretofore, it has been necessary to cross the river on the railroad ferry. A conveyor has been used at the old docks to elevate the sulphur after dumping from cars and to deliver it at the rate of about 80 tons an hour to the head of the chute through which it passed into the holds of the vessels. The new docks will be so constructed that bottom-dump cars will pass up on an elevated structure and will empty into a continuous hopper, with chutes leading at frequent intervals to the hatches of the loading vessel. The delivery will be accomplished by gravity, thus greatly increasing efficiency and lowering the loading cost. A complete equipment of steel bottom-dump hopper cars, each of 50-ton capacity, has been purchased. A railroad extension has been completed to serve these docks, which provides a short haul direct from the mines.

The mines are in a peculiarly favorable location by reason of the fact that they are practically at tidewater. The advantages of location in distributing the product and receiving raw material are obvious. Vessels load sulphur at point of production, and there are rail connections to important southern railway systems.

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FOREIGN SULPHUR DEPOSITS.

SICILY.

According to United States Consul J. E. Haven[1] the production of sulphur in Sicily in 1914 was 334,974 metric tons, 11,000 tons less than in 1914. The production has been declining for several years, owing to the lack of capital; to the shutting down of some of the large mines on account of fires; to competition from the United States, now the principal sulphur-producing country; to the increasing use of pyrite as a source of sulphur; and, finally, in the last two years, to a partial paralysis of the sulphur trade by reason of the war in Europe.

Sulphur shipped by producers in Sicily, 1913–14, in metric tons.

Destination.	From Catania.		Total from Sicily.	
	1913	1914	1913	1914
Sicily	2,529	1,756	8,504	7,604
Italy	32,368	34,891	72,971	89,611
Austria-Hungary	7,455	7,942	36,334	25,304
Belgium	2,053	939	13,321	5,977
Denmark	305	239	305	239
France	114	216	75,186	61,871
Germany	13,422	8,095	31,968	18,824
Greece	13,505	10,964	14,615	15,759
England and Malta	8,992	9,725	16,036	12,998
Netherlands	7,857	6,835	8,975	8,080
Portugal	5,238	1,336	14,754	8,427
Russia	4,156	3,201	25,892	21,289
Spain	4,327	1,915	6,684	9,178
Sweden and Norway	6,700	5,684	27,804	23,877
Turkey in Europe	1,904	1,177	1,911	1,177
United States and Canada	1,383	1,919	1,383	1,919
Central and South America	4,313	944	7,340	944
Egypt	615	1,260	615	1,260
Algeria and Tunis	2,134	462	3,242	2,226
Asiatic Turkey	3,590	3,738	3,596	3,914
British India	5,736	4,316	5,736	4,316
Australia	2,068	62	13,441	1,637
South Africa	1,243	426	13,741	2,486
Other countries	6,756	6,298	10,362	9,396
	138,763	114,340	414,716	338,308

Sulphur produced and shipped in Sicily during the year, and stock on hand Dec. 31, 1908–1914, in metric tons.

Year.	Production.	Shipments.	Stock on hand.	Year.	Production.	Shipments.	Stock on hand.
1908	404,297	375,073	616,419	1912	357,547	447,292	450,917
1909	402,353	364,513	647,880	1913	345,974	414,716	376,356
1910	397,808	393,987	640,711	1914	334,974	338,308	369,001
1911	376,171	453,826	551,422				

The increased cost of the extraction of the ore at the mines induced the producers to petition the Government syndicate that controls the sale of the sulphur (Consorzio obbligatorio per l' industria solfifera siciliana) to advance prices, which request was granted in July, 1914.

[1] Supplement to Commerce Repts., Aug. 18, 1915, pp. 7–9.

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The Consorzio's prices of crude sulphur in bulk on board lighters at the port of Girgenti, Sicily, 1914, are given in the following table:

Government prices of sulphur in Sicily, 1914.

Quality.	Purity.	Price per ton.		Quality.	Purity.	Price per ton.	
		Jan.–July.	Aug.–Dec.			Jan.–July.	Aug.–Dec.
	Per cent.				*Per cent.*		
Yellow superior....	99	$19.30	$19.78	Brown superior....	96	$18.72	$19.20
Yellow inferior.....	97	19.11	19.59	Brown inferior.....	95	18.53	19.01

Crude sulphur in bulk is seldom shipped from Catania. The Consorzio conveys it here for refining and milling and supplies only enough to fill the demand, and in order to discourage its export in the natural state from this port the syndicate has established a higher price from Catania than from Girgenti.

Refined and milled sulphurs, which are chiefly exported from Catania, were in fairly active demand during the year. Local competition is keen and profits small. Owing to the increased cost of refining, increased prices of bagging, and cost of wood for the casks, prices for the sulphurs have advanced.

The market prices of refined and milled sulphur at the end of 1914 per metric ton f. o. b. Catania (in 112-pound sacks), were as follows: Sublimed flowers of sulphur, $34.35; refined sulphur in rolls, $27.98; refined sulphur in lumps, $28.79; and refined ground sulphur, $25.09.

JAPAN.

According to Consul General G. H. Scidmore[1] the exportation of sulphur from Japan has been on the decline for some years and some of the smaller mines have had to shut down. Since the outbreak of the war in Europe, however, foreign demand has improved and quotations have gradually increased. The exports up to the end of August, 1915, were 13,974 short tons, valued at $203,048, an increase of 2,319 tons in quantity and of $20,003 in value, compared with the corresponding period of 1914.

The bulk of Japanese sulphur has been shipped to the United States and Australia and to a less extent to Canada and India. Only an insignificant quantity has gone to Europe. Since the war, however, the export of European sulphur to the Orient has almost ceased and the demand in Europe has increased. Therefore, the demand for Japanese sulphur has increased in the Orient, in America, and also in Europe, and the outlook for the Japanese sulphur industry appears promising.

DESULPHURIZING PROCESSES.

William A. Hall[2] has patented a process for the production of sulphur from pyrite or metallic sulphides in general. It has been

[1] Japanese Advertiser, Sept. 23, 1915.
[2] United States patent 1133636, dated Mar. 30, 1915.

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assumed that in pyrite there is one feeble and one fixed atom of sulphur and that the feeble atom can be removed by distillation whereas the fixed atom can not. Hall has found that under certain conditions of distillation both atoms of sulphur in pyrite act alike and that both can be removed by distillation without prior conversion into sulphur dioxide and hydrogen sulphide and the mutual reaction of these gases.

To bring about the reaction, there is applied to the pyrite a non-oxidizing flame, or preferably the reducing flame from a gas or gas mixture high in hydrogen. The hydrogen in the flame burns to water, which at the high temperature of the interior of the furnace is decomposed into hydrogen and oxygen on contact with the hot pyrite, thus liberating sulphur. The nascent oxygen forms oxide of iron by combining with the iron in the pyrite and the hydrogen again burns to water, or it may combine with some of the sulphur to form hydrogen sulphide. The sulphur which is liberated by the reactions is drawn off. Some sulphur may also be produced by the action of sulphur dioxide and reducing gases like carbon monoxide.

Fine ore is preferably used and a temperature of 700° to 900° C. is maintained in the several compartments of the furnace. Under such conditions sulphur distils very rapidly from the ore.

William A. Hall [1] has invented what is claimed to be improvements in processes of preventing the escape of noxious gases like sulphur dioxide (SO_2) in smelting. The object of the invention is to convert the sulphur dioxide, produced in the focus of the blast furnace, into the harmless material sulphur before it reaches the air. This object is attained preferably by the formation of a reducing agent within the furnace structure at a point well above the focus but where the temperature is still high enough to produce the reducing agent and to bring about the reaction between it and the sulphur dioxide.

The top of the ore body is kept as cool as possible by adding new ore and by continuously spraying with water. By this means ignition of the sulphur vapor is prevented, even in the presence of considerable oxygen. Part of the water percolates downward through the body of the ore, keeping it cooler than in the ordinary smelting process. The water as it is carried downward forms steam which, reacting with the ore, forms hydrogen sulphide. This hydrogen sulphide reacts with the sulphur dioxide present in the gases and forms elementary sulphur ($2H_2S+SO_2=2H_2O+3S$). The sulphur thus formed is carried out as vapor.

In this manner substantially all of the sulphur dioxide produced in the smelter may be decomposed, and the gases and vapors, together with flue dust, leaving the smelter may be passed through a dust-settling chamber of the ordinary construction and the sulphur in solid form recovered, thereby producing a by-product of considerable value.

William A. Hall [2] has described a process to recover sulphur in commercial form from the vapors and gases discharged in smelting operations. A reducing flame is admitted, preferably with steam, into the upper level of the furnace. This prevents the elementary sulphur vapor passing upward in the furnace from being oxidized and it also reduces the sulphur dioxide present to sulphur. The high

[1] United States patent 1133637, dated Mar. 30, 1915.
[2] United States Patent 1134846, dated Apr. 6, 1915.

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temperature produced by this reducing flame is necessary because the sulphur dioxide can not be reduced except at very much higher temperatures than normally exist in the upper portion of the furnace. The reducing flame may be produced by burning water gas or air and water gas from a gas producer containing much carbon monoxide and hydrogen.

In this process the separation of the bulk of the sulphur from the pyrite or other ore and its volatilization are not effected by the reducing flame but primarily by the temperature imparted to the ore charge by combustion in the fusion zone.

The temperature preferred at the top of the ore charge may be 700° C. or a little higher.

W. F. Lamoreaux and C. W. Renwick[1] have invented an improved process for recovering sulphur from gases from roasting, smelting, or calcining furnaces. When such gases are passed through an incandescent layer or body of coke or similar carbonaceous material, sulphur dioxide, for example, is decomposed and sulphur is liberated, as indicated by the following reactions:

$$SO_2+C=CO_2+S;\ SO_2+2CO=2CO_2+S$$

As a specific example: In passing sulphur dioxide from pyrite furnace gases over a bed of coke heated to the required degree by passing an electric current through it, it was determined that when the gas and coke were in contact five seconds 5 per cent of the gas was reduced at a temperature of 800° C. and increasing quantities of the gas up to 1,300° C., when 98 per cent of it was reduced.

Within the limits mentioned, the higher the temperature maintained the more rapid will be the formation of the sulphur. Also, the amount of sulphur formed is found to increase in proportion to the length of time during which the gases are in contact with the incandescent carbon. In other words, either an increase in the depth of the incandescent mass of carbon through which the gases pass or a decrease in the velocity of the gases in passing through such an incandescent mass of carbon will result in a greater percentage of sulphur formed.

PYRITE.

PRODUCTION.

The domestic production of pyrite in 1915 attained a new high level, due chiefly to the unprecedented demand for the ore in making sulphuric acid. The production was 394,124 long tons, valued at $1,674,933, an increase of 57,462 tons in quantity and of $391,587 in value, compared with 1914. The consumption of ore—that is, the combined domestic production (394,124 tons) and imports (964,634 tons)—was 1,358,758, a decrease of 4,521 tons, compared with 1914. This was caused by the falling off in imports. The general resumption of activity at acid plants especially created a great demand for both foreign and domestic pyrite, and the imports, particularly of European pyrite, would have been larger if suitable vessels had been available for the carrying trade.

[1] United States patent 1140310, dated May 18, 1915.

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Pyrite marketed in the United States, 1913–1915.

State.	1913			1914			1915		
	Quantity (long tons).	Value.	Average price per ton.	Quantity (long tons).	Value.	Average price per ton.	Quantity (long tons).	Value.	Average price per ton.
California	70,536	$218,525	$3.10	71,272	$235,129	$3.30	132,270	$496,111	$3.75
Georgia	11,110	55,094	4.96	(a)	(a)	(a)	(a)	(a)	(a)
Illinois	11,246	31,966	2.84	22,538	59,079	2.62	14,849	22,476	1.51
Indiana	1,242	3,115	2.51	1,710	5,281	3.09	972	3,080	3.17
Ohio	13,622	34,998	2.57	7,279	19,718	2.71	10,857	27,404	2.52
Virginia	148,259	587,041	3.96	141,276	556,091	3.94	145,050	729,644	5.03
Wisconsin	25,328	94,727	3.74	14,188	78,460	5.53	13,985	43,354	3.10
Other States[b]	59,995	260,618	4.34	78,399	329,588	4.20	76,141	352,864	4.63
	341,338	1,286,084	3.77	336,662	1,283,346	3.81	394,124	1,674,933	4.25

[a] Included in "Other States."
[b] 1913: Missouri and New York; 1914: Georgia, Missouri, and New York: 1915: Georgia, Missouri, New York, Pennsylvania, and South Carolina.

The historical table showing the production of pyrite in the United States since 1882 was published in this report for 1914 and is therefore omitted. For the benefit of students and others who are interested in the pyrite industry this table will be incorporated at intervals in future reports.

IMPORTS.

Imports for consumption of pyrite containing not more than 3.5 per cent of copper, 1911–1915.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1911	1,006,310	$3,788,803	1914	1,026,617	$4,797,326
1912	970,785	3,841,683	1915	964,634	4,817,977
1913	850,592	3,611,137			

WORLD'S PRODUCTION OF PYRITE.

In the following table is given the world's production of pyrite and the quantity of pure sulphur which it is supposed to replace in the market, estimated on the assumption that the pyrite averages 45 per cent in sulphur.

Wherever possible the figures are taken from the official publication of the country concerned, which is the case with Canada, Belgium, France (in part), the German Empire (in part), and Italy; otherwise, the British Blue Book, known as Mines and Quarries, London, has been used except for 1913, when figures for all countries except Canada, Italy, and the United Kingdom are from Mineral Industry. The rapid increase in the production of pyrite in Canada is worthy of note.

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Iron pyrite produced in principal producing countries and sulphur displaced, 1910–1915, in long tons.

Country.	1910	1911	1912	1913	1914	1915
North America:						
Canada	48,098	73,809	72,791	141,577	203,852	265,008
United States	241,612	301,458	350,928	341,338	336,662	394,124
Europe:						
Belgium	211	120	146	264	(a)	(a)
Bosnia and Herzegovina	56	3,069	6,118	7,580	(a)	(a)
France	246,488	273,565	277,758	306,267	(a)	(a)
German Empire	212,311	214,034	258,517	[b] 224,808	(a)	(a)
Greece	32,767	35,390	29,294	126,838	127,014	(a)
Hungary	91,008	95,231	102,174	104,950	(a)	(a)
Italy	133,492	143,823	244,697	287,477	330,247	(a)
Norway	[c] 324,457	[c] 363,243	[c] 457,014	[c] 434,342	(a)	(a)
Portugal	289,119	[d] 272,869	[d] 333,756	[d] 371,588	(a)	(a)
Russia	55,062	(a)	(a)	(a)	(a)	(a)
Servia	36,255	(e)	45,462	(a)	(a)	(a)
Spain	[f] 289,551	[f] 339,448	[f] 414,438	912,316	(a)	(a)
Sweden	25,044	29,622	31,334	33,779	(a)	(a)
Turkey	[g] 148,130	[g] 104,823	[g] 121,260	(a)	(a)	(a)
United Kingdom	9,380	10,114	10,522	11,427	11,654	(a)
Asia:						
Japan	78,421	72,585	74,594	(a)	(a)	(a)
Oceania:						
Australia	2,916	2,496	(a)	(a)	(a)	(a)
	2,264,378	2,335,699	2,830,803	3,304,551	.....	.....
Sulphur displaced [h]	1,018,970	1,051,065	1,273,861	1,487,048	.....	.....

[a] Statistics not available.
[b] Prussia. Statistics for German Empire not available.
[c] Cupreous iron pyrites.
[d] 1911: Composed of cupreous iron pyrites, 9,595 long tons, and sulphur ore, 263,274 long tons; 1912 and 1913: Sulphur ore.
[e] Quantity not stated. Value, $54,101.
[f] Also 3,180,530 long tons in 1910, 3,232,465 long tons in 1911, and 3,313,145 long tons in 1912, designated as "copper ore and cupreous iron pyrites."
[g] Exported from Stratoni.
[h] Based on estimated 45 per cent of sulphur content.

PYRITE INDUSTRY BY STATES.

CALIFORNIA.

California ranked second among the States in both output and value of pyrite in 1915. The production was 132,270 long tons, valued at $496,111, an increase of 60,998 tons in quantity and of $260,982 in value. California pyrite came as usual from the vicinity of Oakland, Alameda County, and from Keswick, Shasta County. The Dairy Farm Mining Co., operated anew at Vantrent, Placer County.

GEORGIA.

Georgia ranked seventh in quantity and fifth in value of pyrite in 1915—a decrease in production compared with 1914. The pyrite came from the vicinity of Creighton, Cherokee County, where the Standard Pyrites Co. operated, and from Villa Rica, Carroll County, where the Sulphur Mining & Railroad Co. was at work.

ILLINOIS.

Illinois ranked fourth among the States in quantity and eighth in value of the pyrite produced in 1915. The production of the State was 14,849 long tons, valued at $22,476, a decrease of 7,689 tons in quantity and of $36,603 in value, compared with 1914.

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Much of the so-called pyrite obtained in coal mining, not only in Illinois but in Ohio, Indiana, and Pennsylvania, is not pyrite at all, but marcasite. Marcasite has the same composition as pyrite and is with difficulty distinguished from it, especially when in massive form. Both sulphides are commonly referred to by the miners as "sulphur." Marcasite has a slightly lower specific gravity than pyrite (pyrite 4.95 to 5.10; marcasite, 4.85 to 4.90). Its color when fresh, or after treatment with acids, is paler than that of pyrite. When crystallized, it is easily distinguished by its form—marcasite is orthorhombic in form; pyrite crystallizes in the isometric system. With pyrite, moreover, there are certain forms which, like the cube and the pyritohedron, are exceedingly common. Marcasite tarnishes and decomposes more readily than pyrite.

Pyrite in Illinois in 1915 came from in or near Danville, Batestown, Catlin, Oakwood, and Tilton, Vermilion County; and from Glen Carbon, Madison County. The total output of the State was made up of small quantities from many mines.

INDIANA.

The production of pyrite in Indiana in 1915 was 972 long tons, valued at $3,080; a decrease of 738 tons in quantity and of $2,201 in value, compared with 1914. Pyrite in Indiana is a by-product obtained in mining coal and in 1915 it came from West Terre Haute, Seelyville, and Macksville, Vigo County.

MISSOURI.

Two companies produced pyrite in Missouri in 1915, namely, the Rolla Mining Co., at Rolla, Phelps County, and the Beulah Mining Co., at Kelso, Scott County.

NEW YORK.

During 1915 pyrite came from two localities in New York. The St. Lawrence Pyrites Co. operated the Anna mine, at Hermon, St. Lawrence County; and production was also reported from the Northern Ore Co., at Edwards, St. Lawrence County. The pyrite concentrates produced at Edwards are obtained in the concentration of zinc ore. The Cole mine near Gouverneur, which has been worked for many years by the Hinckley Fiber Co., was shut down during the entire year. New York ranked third among the States in both quantity and value of the pyrite produced.

OHIO.

The production of pyrite in Ohio in 1915 was 10,857 long tons, valued at $27,404, an increase of 3,578 tons in quantity and of $7,686 in value, compared with 1914. The production without doubt would have been much larger had it not been for the fact that several of the mines producing by-product pyrite were idle for long periods. The pyrite came chiefly from New Philadelphia, Beidler, Dennison, Joyce, Midvale, Mineral City, Roswell, Uhrichsville, and Wainwright, Tuscarawas County; Tippecanoe, Harrison County; Brilliant, Connorville, Dillonvale, Herrick, and Rayland, Jefferson County.

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PENNSYLVANIA.

A small quantity of pyrite was produced in connection with coal mining in Clearfield County in 1915.

SOUTH CAROLINA.

An important production of pyrite was reported from Kershaw County by A. K. Blakeney.

VIRGINIA.

Virginia, as usual, ranked first among the States in both output and value of pyrite in 1915, there being marketed 145,050 long tons of pyrite, valued at $729,644, an increase of 3,774 tons in quantity and of $173,553 in value. The great increase in value was due to the demand for the pyrite for use in making acid, a demand which greatly increased toward the end of the year and continued in 1916.

The pyrite came from the Arminius mine, of the Arminius Chemical Co.; the mine of the Sulphur Mining & Railroad Co., and the Boyd-Smith mine, all near Mineral, Louisa County; from the Gossan mine, of the General Chemical Co., at Monarat, Carroll County; and from the Bertha Mineral Co., Austinville, Wythe County. The Cabin Branch Mining Co., which heretofore has been an important producer of pyrite at Dumfries, Prince William County, reported no output in 1915.

WISCONSIN.

The pyrite (marcasite) produced in southwestern Wisconsin and northwestern Illinois combined is given in this report as produced in Wisconsin, because nearly all the production comes from Wisconsin, and also because it is impossible to differentiate the production of the two States—a condition caused by the fact that low-grade blende containing marcasite and originating in both States is shipped to separating plants in both States, so that it is impossible to credit correctly the original State quotas. Part of this pyrite is obtained with the zinc ores mined in the southwestern part of Wisconsin, in what is usually known as the Wisconsin or upper Mississippi Valley zinc district, which includes also Illinois and Iowa, though no zinc ore was produced in Iowa in 1915. The zinc sulphide and the iron sulphide from both States are separated at Linden, Platteville, Cuba City, and Mineral Point, Wis., and at Galena, Ill.

SULPHURIC ACID.

CONDITION OF THE INDUSTRY.

There is no foreign competition in sulphuric acid, because of heavy transportation charges and because the American producers have been able to make this and other acids, like nitric and hydrochloric, at prices which render their importation unprofitable. Until about the middle of 1915 American manufacturers were able to supply all domestic needs, but as the war in Europe went on and the demand for munitions increased, the need of sulphuric acid became so great

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that manufacturers have had great difficulty in supplying the demand. As a consequence, many American consumers have been unable to get enough acid for their technochemical operations—for example, in the manufacture of the soluble or acid phosphates used in the fertilizer industry.

Prices have increased prodigiously, especially for the stronger grades of acid. By-product acid smelters that were compelled to install acid-making plants have been and are in a position to reap most unexpected profits. Indeed, what was formerly the by-product has in one place become the main product, and the metal has become the secondary product.

Important additions have been made to existing plants, new plants have been constructed at many places, and plants that were formerly idle have been put in operation. Ordinary concentration plants for producing the strongest grades of acid may be built in a comparatively short time but not plants designed for the production of acid itself. It takes time to construct these complex, elaborate plants, but in spite of the high cost of labor and material much capital is being invested in them. The output of these plants will be seen in the country's production for 1916.

PRODUCTION.

The production, in 1915, expressed in terms of 50° acid, was 3,868,152 short tons, valued at $29,869,080, to which must be added 189,795 short tons of oleum, or fuming acid of different strengths, valued at $2,787,971, a total of 4,057,947 short tons, valued at $32,657,051. These figures include by-product acid—that is, acid produced at copper and zinc smelters. The production of acid from this source in 1915, expressed in terms of 50° acid, was 1,056,830 short tons, valued at $7,042,126, together with 59,189 short tons of oleum of different strengths, valued at $579,115.

Sulphuric acid produced in the United States in 1899, 1904, 1909, 1914, and 1915.

Grade.	1899			1904			1909		
	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.	Price per ton.	Quantity short tons).	Value.	Price per ton.
50° Baumé.[a]	953,439	$7,965,832	$8.35	1,169,141	$8,314,646	$7.11	1,624,178	$8,494,451	$5.23
60° Baumé	17,012	246,284	14.47	48,688	581,523	11.94	186,900	1,089,350	5.78
66° Baumé	382,279	6,035,069	15.78	411,165	5,917,699	14.38	558,078	6,719,259	12.04
Other grades	.....	.....	.....	[a] 13,268	361,018	27.20	[a] 31,349	476,135	15.18
	1,352,730	14,247,185	.....	1,642,262	15,174,886	.....	2,400,505	16,779,195	.....
Total reduced to 50° Baumé	[b]1,548,123	.....	9.20	[c]1,869,437	.....	.....	[d]2,748,527	.....	.....

[a] Reported as oleum by the census.

[b] Includes 764,355 tons, with an assigned value of $7,032,066, consumed in establishments where manufactured; and also sulphuric acid produced by establishments engaged primarily in the manufacture of other products.

[c] Includes 968,445 tons, with an assigned value of $7,232,675, consumed in establishments where manufactured; and also sulphuric acid produced by establishments engaged primarily in the manufacture of other products.

[d] Includes 1,271,535 tons, with an assigned value of $6,694,436, consumed in establishments where manufactured; and also sulphuric acid produced by establishments engaged primarily in the manufacture of other products.

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Sulphuric acid produced in the United States in 1899, 1904, 1909, 1914, and 1915—Continued.

Grade.	1914			1915		
	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.	Price per ton.
50° Baumé	1,628,402	$9,712,056	$5.96	[a] 1,518,271	$10,681,246	$7.04
60° Baumé	551,955	3,376,242	6.12	657,076	4,976,453	7.57
66° Baumé	916,192	10,509,471	11.47	1,019,024	14,211,381	13.95
Other grades	65,890	882,158	13.39	[b] 189,795	2,787,971	14.69
	3,162,439	24,479,927	7.74	3,384,166	32,657,051	9.65
Total reduced to 50° Baumé	[c] 3,762,417	[a] 24,163,331	6.42	[d] 3,868,152	29,969,080	7.72

[a] Includes not only acid reported as 50°, but also 52°, 53°, and 55° acid reduced to the equivalent.
[b] Includes stronger acid reported as oleum, etc., carrying varying percentages of free SO_3.
[c] Exclusive of 21,993 short tons of fuming acid, not convertible, valued at $316,596.
[d] Exclusive of "other grades."

PRODUCTION AT COPPER AND ZINC SMELTERS.

Sulphuric acid produced at copper and zinc smelters, 1912–1915.[a]

[Reduced to 60° Baumé acid.]

Source.	1912			1913		
	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.	Price per ton.
Copper smelters	[b] 321,156	[b] $1,985,704	[b] $6.18	336,019	$2,205,627	$6.56
Zinc smelters	[b] 292,917	[b] 2,255,237	[b] 7.70	296,218	2,140,645	7.23
	[b] 614,073	[b] 4,240,941	[b] 6.91	632,237	4,346,272	6.87
Total reduced to 50° Baumé	[c] 764,237	.....	.....	790,296	.....	.....

Source.	1914			1915		
	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.	Price per ton.
Copper smelters	348,727	$2,215,690	$6.25	360,522	$2,749,633	$7.63
Zinc smelters	411,911	2,974,603	7.22	484,942	4,292,493	8.85
Other strengths	.....	.....	.....	[d] 59,189	579,115	9.78
	760,638	5,190,293	6.82	904,653	7,621,241	8.42
Total reduced to 50° Baumé	950,798	.....	.....	[e] 1,056,830	.....	.....

[a] The acid reported to the Survey includes that of 50°, 53°, 55°, 60°, and 66° Baumé strengths, and a small quantity of electrolyte and oleum. All strengths, with the exception of the electrolyte, have been reduced to both 50° and 60° Baumé, as given in the table.
[b] Inclusive of a small quantity of electrolyte.
[c] Exclusive of a small quantity of electrolyte.
[d] Includes stronger acid reported as oleum, etc., carrying varying percentages of free SO_3.
[e] Exclusive of "Other strengths."

During the last few years it has been customary, in giving statistics of production, to reduce different strengths of acid to reported 50° Baumé whenever sufficient data were available for conversion, but as the production of stronger acid is becoming more important this is now classed separately and no reduction is made in terms of 50° acid.

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Too much weight must not be attached to the values given in the tables, for the prices of sulphuric acid have varied widely during the year. Producers who had previously entered into long-time contracts sold acid at prices much below those now current, especially during the last part of 1915. The trade in strong acids was active on account of the demand for explosives and other war munitions, but this demand came only after the first quarter of 1915 and was very strong only during the last half of the year. Before that time some acid plants were shut down. The average prices given are, therefore, much below those which ruled on the market at the close of the

GENERAL USES.

Sulphuric acid is probably used in a greater variety of ways in the chemical arts than any other substance. According to Lunge,[1] the principal applications of the acid are as follows:

1. *In a more or less dilute state (say from 144° Twad. downward).*—For making sulphate of soda (salt cake) and hydrochloric acid, and therefore ultimately for soda ash, bleaching powder, soap, glass, and innumerable other products. Further, for superphosphates and other artificial manures. These two applications probably consume nine-tenths of all the sulphuric acid produced. Further applications are for preparing sulphurous, nitric, phosphoric, hydrofluoric, boric, carbonic, chromic, oxalic, tartaric, citric, acetic, and stearic acids; in preparing phosphorus, iodine, bromine, the sulphates of potassium, ammonium, barium (blanc fixe), calcium (pearl-hardening); especially also for precipitating baryta or lime as sulphates for chemical processes; sulphates of magnesium, aluminum, iron, zinc, copper, mercury (as intermediate stage for calomel and corrosive sublimate); in the metallurgy of copper, cobalt, nickel, platinum, silver; for cleaning (pickling) sheet iron to be tinned or galvanized for cleaning copper, silver, etc.; for manufacturing potassium bichromate; for working galvanic cells, such as are used in telegraphy, in electroplating, etc.; for manufacturing ordinary ether and the composite ethers; for making or purifying many organic coloring matters, especially in the oxidizing mixture of potassium bichromate and sulphuric acid; for parchment paper; for purifying many mineral oils, and sometimes coal gas; for manufacturing starch, sirup, and sugar; for the saccharification of corn; for neutralizing the alkaline reaction of fermenting liquors, such as molasses; for effervescent drinks; for preparing tallow previously to melting it; for recovering the fatty acids from soapsuds; for destroying vegetable fibers in mixed fabrics; generally, in dyeing, calico printing, tanning, as a chemical reagent in innumerable cases; in medicine against lead poisoning, and in many other cases.

2. *In a concentrated state.*—For manufacturing the fatty acids by distillation; purifying colza oil; for purifying benzene, petroleum, paraffin oil, and other mineral oils; for drying air, especially for laboratory purposes, but also for drying gases for manufacturing processes (for this, weaker acid also, of 140° Twad., can be used); for the production of ice by the rapid evaporation of water in a vacuum; for refining gold and silver, desilvering copper, etc.; for making organo-sulphonic acids; manufacturing indigo; preparing many nitro compounds and nitric ethers, especially in manufacturing nitroglycerin, pyroxylin, nitrobenzene, picric acid, and so forth.

3. *As Nordhausen fuming oil of vitriol (anhydride).*—For manufacturing certain organo-sulphonic acids (in the manufacture of alizarin, eosin, indigo, etc.); for purifying ozokerite; for making shoe blacking; for bringing ordinary concentrated acid up to the highest strength as required in the manufacture of pyroxylin; and for other purposes.

The most important of the classes of manufacture enumerated above, so far as the consumption of the acid is involved, are (1) the manufacture of fertilizers; (2) the refining of petroleum products; (3) the iron, steel, and coke industries; (4) the manufacture of nitrocellulose, nitroglycerin, celluloid, etc.; and (5) general metallurgical and chemical practice.

[1] Manufacture of sulphuric acid and alkali, vol. 1, pt. 2, pp. 1169, 1170, 1903.

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A NEW USE FOR SULPHURIC ACID.

A prospective use for sulphuric acid which has large possibilities has been proposed by C. B. Lippman, of the University of California.[1] The announcement is to the effect that apparently beneficial results have been obtained from the application of sulphuric acid to the alkali soils of the West. Views were shown at the convention of engineers last fall in San Francisco exhibiting crops grown on test plots that had received 2.5 to 7.5 tons of sprayed sulphuric acid to the acre. The ground prior to the application had been unfit for agriculture, owing to its content of alkali. There is much alkali land around certain acid plants and, in fact, in many other parts of the West. Thus the possibility of advantageously converting damaging fumes from western smelters into a useful product and finding a local outlet for the product under normal conditions is one of great importance to the West. The development of this application will no doubt be watched with much interest.

[1] Eng. and Min. Jour., vol. 100, Oct. 30, 1915.

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MINERAL WATERS.

By RICHARD B. DOLE.

CHARACTER OF STATISTICS.

The statistics here given have been compiled from individual reports furnished by the owners or operators of springs and include, so far as can be ascertained, only natural waters that are bottled and sold in their natural state or only slightly altered from their natural state. Natural still waters that have been artificially carbonated, natural carbonated waters that have lost part of their carbon dioxide, and waters from which iron has been removed are included; but artificial waters and natural waters that have been flavored, concentrated, fortified, diluted, or otherwise essentially modified in chemical character are excluded if available information indicates such treatment. Water given away or consumed at spring resorts, which constitutes a large part of the annual production, is excluded. Waters sold at flat or meter rates, delivered to consumers through pipes, or otherwise obviously municipal supplies or adjuncts to them are excluded. This is the nearest practicable conformity with the commonly accepted definition of natural mineral water. No distinction is made between mineral water flowing or pumped from a natural spring and that flowing or pumped from a dug, bored, driven, or drilled well. Many of the best-known mineral waters in the United States come not from natural springs but from wells.

Distinction for statistical purposes between table and medicinal waters is entirely arbitrary. Most table waters are clear, sparkling, and without distinct mineral taste or odor; many medicinal waters are highly mineralized and have distinct mineral taste and odor. Yet some table waters are more strongly mineralized than some medicinal waters, and many medicinal waters contain less mineral matter than certain city supplies. The basis here used for distinguishing medicinal from table waters is the report regarding the spring, and this distinction is based in turn on the operator's knowledge that some of his customers buy the water to use regularly on their tables and others buy it for an aid during illness. A few strongly mineralized waters are not sold as table waters, and a few widely sold table waters are not used medicinally, but many waters are sold for both uses, though the reported sales of several medicinal waters have distinctly decreased in the last few years.

MINERAL-WATER TRADE IN 1915.

OUTPUT AND VALUE.

The number of active mineral springs was smaller and the production was less though the value was greater in 1915 than in 1914. The decrease in production was 2,244,963 gallons, or 4 per cent. The increase in value of medicinal waters was $60,506 and in value of table waters was $185,960; thus the total increase in value of sales

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was $246,466, or 5 per cent. The increase in business is slightly less than the decrease in imports of foreign waters, and this, coupled with the increase of price per gallon from 9 to 10 cents, indicates increased sales of moderately high-priced domestic waters that have become valuable substitutes for waters previously imported. Production was reported from 45 springs for the first time in 1915.

The State of New York led in number of commercial springs and in quantity of mineral water sold, and was second to Wisconsin in total value of production and in value of table waters, though it ranked only seventh in value of medicinal waters, in which California and Indiana took, respectively, first and second rank. Virginia and Texas were also heavy producers of medicinal waters. In value of table waters California, Maine, Massachusetts, and Pennsylvania followed, in order, Wisconsin and New York. In total value of production Massachusetts, Ohio, Minnesota, and Virginia followed, in order, the same two States. More than 30 springs were active in each of 9 States, more than 1,000,000 gallons of mineral water was sold in each of 15 States, and more than $100,000 worth of mineral water was produced in each of 15 States.

Mineral waters sold in the United States, 1914 and 1915.

1914.

State.	Commercial springs.	Quantity sold.	Average price per gallon.	Value of medicinal waters.	Value of table waters.	Total value.
		Gallons.	*Cents.*			
Alabama	15	169,279	10	$7,614	$9,511	$17,125
Arkansas	18	1,314,159	9	67,260	47,945	115,205
California	48	2,282,569	22	212,067	285,856	497,923
Colorado	12	968,260	12	7,132	106,281	113,413
Connecticut	42	2,341,082	6	2,301	132,177	134,478
Florida	11	231,160	11	3,315	21,423	24,738
Georgia	19	652,566	8	8,601	41,058	49,659
Illinois	21	1,760,030	5	3,586	77,721	81,307
Indiana	17	382,247	36	125,975	12,143	138,118
Iowa	7	303,527	10	15,141	15,038	30,179
Kansas	15	272,722	21	52,065	4,375	56,440
Kentucky	12	437,334	13	32,950	23,544	56,494
Louisiana	5	576,138	6	3,643	27,919	31,562
Maine	29	1,062,631	31	88,348	244,886	333,234
Maryland	10	1,691,776	7	0	124,403	124,403
Massachusetts	52	3,084,385	6	19,435	154,889	174,324
Michigan	22	931,343	8	12,252	58,058	70,310
Minnesota	15	5,639,232	3	509	193,532	194,041
Mississippi	8	415,904	18	72,100	968	73,068
Missouri	36	583,288	13	56,647	18,146	74,793
Montana	3	100,700	6	10	5,545	5,555
Nebraska	3	10,900	14	650	840	1,490
Nevada	3	221,942	1	0	3,191	3,191
New Hampshire	7	194,418	6	875	10,856	11,731
New Jersey	17	1,710,030	9	1,500	154,149	155,649
New Mexico	3	41,000	16	90	6,510	6,600
New York	69	8,201,202	8	61,845	611,068	672,913
North Carolina	17	158,226	14	16,496	5,468	21,964
North Dakota	4	408,000	2	1,050	7,100	8,150
Ohio	35	3,558,413	4	19,232	126,354	145,586
Oklahoma	12	804,675	3	2,697	24,209	26,906
Oregon	7	57,800	22	2,115	10,695	12,810
Pennsylvania	47	2,457,626	9	11,372	202,380	213,752
Rhode Island	6	438,702	7	0	29,639	29,639
South Carolina	13	293,949	16	41,231	6,840	48,071
South Dakota	3	145,647	6	508	8,491	8,999
Tennessee	23	943,502	6	35,102	21,639	56,741
Texas	31	766,597	12	91,542	1,472	93,014
Vermont	4	51,151	17	1,700	6,900	8,600
Virginia	50	2,906,976	10	107,332	186,180	293,512
Washington	6	180,787	16	19,062	9,715	28,777
West Virginia	10	307,890	16	19,702	29,427	49,129
Wisconsin	35	5,145,452	11	69,412	518,961	588,373
Wyoming	3	69,658	13	3,950	4,852	8,802
Other States [a]	4	63,291	2	23	1,537	1,560
	829	54,358,466	9	1,298,437	3,593,891	4,892,328

[a] Includes Delaware, District of Columbia, and Utah.

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Mineral waters sold in the United States, 1914 and 1915—Continued.

1915.

State.	Commercial springs.	Quantity sold.	Average price per gallon.	Value of medicinal waters.	Value of table waters.	Total value.
		Gallons.	*Cents.*			
Alabama	14	86,499	10	$8,213	$699	$8,912
Arkansas	13	1,377,093	9	70,862	48,210	119,072
California	50	2,789,871	19	206,181	326,636	532,817
Colorado	14	858,185	7	6,543	56,561	63,104
Connecticut	38	1,774,213	6	5,991	95,979	101,970
Florida	7	118,920	11	1,476	11,040	12,516
Georgia	19	746,068	7	9,207	44,572	53,779
Illinois	23	1,559,489	5	5,382	69,908	75,290
Indiana	18	542,053	35	172,215	16,859	189,074
Iowa	8	198,739	9	7,252	11,282	18,534
Kansas	14	155,938	40	59,721	3,348	63,069
Kentucky	11	459,841	14	47,300	15,978	63,278
Louisiana	5	513,838	6	3,307	27,464	30,771
Maine	24	1,115,648	30	89,148	248,855	338,003
Maryland	10	1,433,406	7	0	105,581	105,581
Massachusetts	48	3,872,192	5	14,598	169,535	184,133
Michigan	19	913,765	8	5,165	67,546	72,711
Minnesota	17	3,493,887	4	1,197	135,062	136,259
Mississippi	11	259,370	18	44,460	1,179	45,639
Missouri	33	1,000,961	8	65,394	17,969	83,363
Montana	3	114,245	6	55	6,548	6,603
Nebraska	3	8,770	11	145	817	962
Nevada	3	303,150	1	0	4,294	4,294
New Hampshire	7	176,385	4	875	5,862	6,737
New Jersey	13	1,479,479	8	2,520	113,706	116,226
New Mexico	4	42,400	16	4,370	2,310	6,680
New York	75	8,411,616	8	74,023	637,674	711,697
North Carolina	17	132,813	14	14,907	3,838	18,745
North Dakota	3	475,000	2	750	8,000	8,750
Ohio	36	3,504,343	4	10,923	122,493	133,416
Oklahoma	13	890,392	3	5,860	18,145	24,005
Oregon	7	28,747	30	1,942	6,787	8,729
Pennsylvania	47	2,136,218	8	11,733	163,065	174,798
Rhode Island	6	385,624	6	0	24,574	24,574
South Carolina	11	480,051	14	61,452	6,417	67,869
South Dakota	3	176,000	5	0	9,360	9,360
Tennessee	23	703,566	6	21,584	17,720	39,304
Texas	29	835,142	12	99,700	300	100,000
Vermont	5	61,540	23	4,250	10,132	14,382
Virginia	50	3,027,528	8	108,943	128,875	237,818
Washington	5	158,865	7	6,150	5,553	11,703
West Virginia	9	314,909	16	19,751	30,520	50,271
Wisconsin	36	4,861,734	22	81,395	970,010	1,051,405
Wyoming	5	68,584	13	4,000	5,059	9,059
Other States [a]	3	66,426	5	3	3,439	3,442
	812	52,113,503	10	1,358,943	3,779,851	5,138,794

[a] Includes Delaware and Utah.

Sales were reported from 812 springs in 1915 as compared with 829 in 1913. No reports of mineral-water sales were received from Arizona, District of Columbia, or Idaho, and less than three active springs were reported from Delaware and Utah; three or more springs were active in every other State in the Union. Sales exceeded 5,000,000 gallons in one State (New York), and in one State (Wisconsin) the total production was valued at more than $1,000,000. The total value of the output exceeded $500,000 in Wisconsin, New York, and California, and these three States produced 31 per cent of the total quantity and 45 per cent of the total value of domestic mineral waters marketed in 1915.

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CONDITION OF TRADE.

Though the total value of production in 1915 exceeded that in 1914 the maximum production and value of 1911 were not equaled. There seems to be a general tendency toward increased sales of table waters, decreased sales of medicinal waters, decreased number of active springs, and greatly increased sales of a few waters. The statistics of production in the United States during the last five years, shown in the following table, indicate a gradual decline in quantity sold since 1911.

Mineral waters sold in the United States, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	732	63,788,552	$6,837,888	11
1912	746	62,281,201	6,615,671	11
1913	838	57,867,399	5,631,391	10
1914	829	54,358,466	4,892,328	9
1915	812	52,113,503	5,138,794	10

In 1915, as in 1913 and 1914, nearly half the trade in mineral waters was in the hands of a few very large producers. Five springs, as in 1913 and 1914, sold more than 1,000,000 gallons each, and 16 springs, as compared with 18 in 1914 and 20 in 1913, sold more than 500,000 gallons each. The total output of these 16 springs was 18,483,823 gallons, valued at $2,016,445. The total output of the 20 largest producers in 1915 was 20,312,142 gallons, valued at $2,087,895, as compared with an output by the 20 largest producers in 1914 of 21,356,203 gallons, valued at $1,636,316. Fifty springs in 1915 did more than $20,000 worth of business each, selling a total of 23,717,725 gallons for $3,421,153. Fifty-one springs in 1914 did more than $20,000 worth of business each, selling a total of 26,731,787 gallons for $3,050,563. Corresponding figures for 1913 are 54 springs, 28,769,596 gallons, and $3,642,964. The decrease in quantity of mineral waters sold in 1915 by the large producers is equivalent to 11 per cent and the increase in value is equivalent to 12 per cent. These differences indicate a tendency toward increase in price during 1915. In addition to those large producers, however, there were 762 others whose sales ranged from $5 to $20,000 and whose fields of activity are general. The details of the fluctuations in the trade by States are given in the accompanying table.

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Comparative production of mineral waters, 1914–1915.

State.	1914			1915			Increase or decrease in number of springs.	Increase or decrease in quantity sold.		Increase or decrease in value of product.	
	Commercial springs.	Quantity sold.	Value.	Commercial springs.	Quantity sold.	Value.					
		Gallons.			*Gallons.*			*Gallons.*	*Per cent.*	*Dollars.*	*Per cent.*
Alabama	15	169,279	$17,125	14	86,499	$8,912	− 1	− 82,780	−49	− 8,213	− 48
Arkansas	18	1,314,159	115,205	13	1,377,093	119,072	− 5	+ 62,934	+ 5	+ 3,867	+ 3
California	48	2,282,569	497,923	50	2,789,871	532,817	+ 2	+ 507,302	+22	+ 34,894	+ 7
Colorado	12	968,260	113,413	14	858,185	63,104	+ 2	− 110,075	−11	− 50,309	− 44
Connecticut	42	2,341,082	134,478	38	1,774,213	101,970	− 4	− 566,869	−24	− 32,508	− 24
Florida	11	231,160	24,738	7	118,920	12,516	− 4	− 112,240	−49	− 12,222	− 49
Georgia	19	652,566	49,659	19	746,068	53,779	0	+ 93,502	+14	+ 4,120	+ 8
Illinois	21	1,760,030	81,307	23	1,559,489	75,290	+ 2	− 200,541	−11	− 6,017	− 7
Indiana	17	382,247	138,118	18	542,053	189,074	+ 1	+ 159,806	+42	+ 50,956	+ 37
Iowa	7	303,327	30,179	8	198,739	18,534	+ 1	− 105,088	−35	− 11,645	− 39
Kansas	15	272,722	56,440	14	155,938	63,060	− 1	− 116,784	−43	+ 6,629	+ 12
Kentucky	12	437,334	56,494	11	459,841	63,278	− 1	+ 22,507	+ 5	+ 6,784	+ 12
Louisiana	5	576,138	31,562	5	513,838	30,771	0	− 62,300	−11	− 791	− 3
Maine	29	1,062,631	333,234	24	1,115,648	338,003	− 5	+ 33,017	+ 3	+ 4,769	+ 1
Maryland	10	1,691,776	124,403	10	1,433,406	105,581	0	− 258,370	−15	− 18,822	− 15
Massachusetts	52	3,084,385	174,324	48	3,372,192	184,133	− 4	+ 787,807	+26	+ 9,809	+ 6
Michigan	22	981,343	70,310	19	913,765	72,711	− 3	− 17,578	− 2	+ 2,401	+ 3
Minnesota	15	5,639,282	194,041	17	3,493,887	136,259	+ 2	−2,145,345	−38	− 57,782	− 30
Mississippi	8	415,904	73,068	11	259,370	45,639	+ 3	− 156,534	−38	− 27,429	− 38
Missouri	36	583,288	74,793	33	1,000,961	83,363	− 3	+ 417,673	+72	+ 8,570	+ 12
Montana	3	100,700	5,555	3	114,245	6,603	0	+ 13,545	+14	+ 1,048	+ 19
Nebraska	3	10,900	1,490	3	8,770	962	0	− 2,130	−20	− 528	− 35
Nevada	3	221,942	3,191	3	303,150	4,294	0	+ 81,208	+37	+ 1,103	+ 35
New Hampshire	7	194,418	11,731	7	176,385	6,737	0	− 18,033	− 9	− 4,994	− 43
New Jersey	17	1,710,030	155,649	13	1,479,479	116,226	− 4	− 230,551	−14	− 39,423	− 25
New Mexico	3	41,000	6,600	4	42,400	6,680	+ 1	+ 1,400	+ 3	+ 80	+ 1
New York	69	8,201,202	672,913	75	8,411,616	711,697	+ 6	+ 210,414	+ 3	+ 38,784	+ 6
North Carolina	17	158,226	21,964	17	132,813	18,745	0	− 25,413	−16	− 3,219	− 15
North Dakota	4	408,000	8,150	3	475,000	8,750	− 1	+ 67,000	+16	+ 600	+ 7
Ohio	35	3,558,413	145,586	36	3,504,343	133,416	+ 1	− 54,070	− 2	− 12,170	− 8
Oklahoma	12	804,675	26,906	12	890,392	24,005	+ 1	+ 85,717	+11	− 2,901	− 11
Oregon	7	57,800	12,510	7	28,747	8,729	0	− 29,053	−50	− 4,081	− 32
Pennsylvania	47	2,457,626	213,752	47	2,136,218	174,798	0	− 321,408	−13	− 38,954	− 18
Rhode Island	6	438,702	29,639	6	385,624	24,574	0	− 53,078	−12	− 5,065	− 17
South Carolina	13	296,949	48,071	11	480,051	67,869	− 2	+ 186,102	+63	+ 19,798	+ 41
South Dakota	3	145,647	8,999	3	176,000	9,360	0	+ 30,353	+21	+ 361	+ 4
Tennessee	23	943,502	56,741	23	703,566	39,304	0	− 239,936	−25	− 17,437	− 31
Texas	31	766,597	93,014	29	835,142	100,090	− 2	+ 68,545	+ 9	+ 7,076	+ 8
Vermont	4	51,151	8,600	5	61,540	14,382	+ 1	+ 10,389	+20	+ 5,782	+ 67

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Comparative production of mineral waters, 1914–1915—Continued.

State.	1914			1915			Increase or decrease in number of springs.	Increase or decrease in quantity sold.		Increase or decrease in value of product.	
	Commercial springs.	Quantity sold.	Value.	Commercial springs.	Quantity sold.	Value.					
		Gallons.			*Gallons.*			*Gallons.*	*Per cent.*	*Dollars.*	*Per cent.*
Virginia	50	2,906,976	$293,512	50	3,027,528	$237,818	0	+ 120,552	+ 4	− 55,694	− 19
Washington	6	180,787	28,777	5	158,865	11,703	− 1	− 21,922	−12	− 17,074	− 59
West Virginia	10	307,890	49,129	9	314,909	50,271	− 1	+ 7,019	+ 2	+ 1,142	+ 2
Wisconsin	35	5,145,452	588,373	36	4,861,734	1,051,405	+ 1	− 283,718	− 6	+463,032	+ 79
Wyoming	3	69,658	8,802	5	68,584	9,059	+ 2	− 1,074	− 2	+ 257	+ 3
Other States [a]	4	63,291	1,560	3	66,426	3,442	− 1	+ 3,135	+ 5	+ 1,882	+121
	829	54,358,466	4,992,328	812	52,113,503	5,138,794	−17	−2,244,963	− 4	+246,466	+ 5

[a] Includes in 1914 Delaware, District of Columbia, and Utah; in 1915 Delaware and Utah.

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RANGE OF PRICE.

Effort has been made in compiling the following table, giving the quantity and value of mineral water sold within certain ranges of price during 1914 and 1915, to eliminate freight and marketing charges and the value of returnable containers, and thus to give the net value of the waters at their sources.

Range of price per gallon of mineral water, 1914-1915.

1914.

Price per gallon (in cents).	Number of springs.	Quantity sold (gallons).	Value.	Percentage of number of springs.	Percentage of total quantity.	Percentage of total value.
Not more than 2	47	6,132,309	$86,803	6	11	2
More than 2 and not more than 5	213	17,475,662	656,734	26	32	13
More than 5 and not more than 10	265	20,518,356	1,649,027	32	38	34
More than 10 and not more than 20	135	6,802,412	981,820	17	13	20
More than 20 and not more than 30	65	1,149,407	287,933	8	2	6
More than 30 and not more than 50	59	1,438,353	612,120	7	3	12
More than 50 and not more than 100	23	799,131	564,267	3	1	12
More than 100	5	42,836	53,624	1	0	1
	[a] 812	54,358,466	4,892,328	100	100	100

1915.

Not more than 2	56	7,281,647	$93,930	7	14	2
More than 2 and not more than 5	211	16,119,591	632,103	27	31	12
More than 5 and not more than 10	249	19,096,994	1,570,156	32	37	31
More than 10 and not more than 20	138	4,628,897	710,330	17	9	14
More than 20 and not more than 30	59	1,197,670	291,708	7	2	6
More than 30 and not more than 50	49	2,897,830	1,151,055	6	5	22
More than 50 and not more than 100	24	811,753	574,654	3	2	11
More than 100	8	79,121	114,863	1	0	2
	[b] 794	52,113,503	5,138,794	100	100	100

[a] Exclusive of 17 springs whose waters are used exclusively for the manufacture of soft drinks.
[b] Exclusive of 18 springs whose waters are used exclusively for the manufacture of soft drinks.

Practically four-fifths of the mineral water was sold at prices ranging from one-half cent to 10 cents a gallon during 1913, 1914, and 1915. The percentage sold for more than 30 cents a gallon is more than double what it was in 1914 and constitutes 8 per cent of the quantity sold in 1915. The demand for moderately high-priced table waters to replace waters formerly imported apparently sustained the market of many well-known domestic waters in spite of increases in price. The water from 516 springs was sold for 10 cents or less a gallon, and the water from eight springs was sold for $1 to $5 a gallon. The average price per gallon in 1915 was 10 cents. The table on page 310 indicates a present trend toward slight increase in price.

SOFT DRINKS.

Returns show that the quantity of mineral water used in the manufacture of soft drinks during 1915 was 9 per cent less than that used during 1914. The gross distribution of the consumption during 1915 is indicated in the following table. Massachusetts and Wisconsin, as in 1914, head the list with consumptions greater than 500,000 gallons, and more than 100,000 gallons of mineral water was used in the

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manufacture of soft drinks in 15 other States during 1915. This recorded consumption does not represent the total production of soft drinks in the United States, as most of these beverages are compounded with municipal and private supplies not classified as mineral waters.

Mineral water used in the manufacture of soft drinks, 1915.

Rank.	State.	Quantity.	Rank.	State.	Quantity.
		Gallons.			*Gallons.*
1	Massachusetts	876,408	11	South Carolina	220,651
2	Wisconsin	802,417	12	Kentucky	185,385
3	Minnesota	435,601	13	Iowa	152,411
4	Virginia	350,753	14	Michigan	144,728
5	New York	340,976	15	Maryland	120,000
6	Connecticut	320,469	16	New Hampshire	118,250
7	Illinois	267,890	17	Arkansas	100,000
8	Pennsylvania	261,407		Other States	530,508
9	North Dakota	250,000			
10	Colorado	230,891			5,708,735

EXPORTS.

Large quantities of a few domestic waters are exported, but no statistics regarding such shipments are available. The quantity and the value of these waters are included in the statistics of production for the United States.

IMPORTS.

The total imports of natural and artificial waters entered for consumption in 1915, as reported by the Bureau of Foreign and Domestic Commerce, Department of Commerce, amounted to 1,528,181 gallons, valued at the points of shipment at $551,648; this is a decrease of 45 per cent in quantity and 36 per cent in value from imports in 1914. Though the imports have decreased every year since 1911 the declines in 1914 and 1915 are more than might be attributed to decreased demand for foreign waters, and the average price per gallon was 3 cents greater in 1914 and 5 cents greater in 1915. Eighty-eight per cent of the imported water consumed in the United States during 1915 came from France and Germany, though the imports from those countries were notably less than in 1913, those from Germany having dropped to about half the quantity imported during 1914. The imports from Austria-Hungary dropped from slightly more than 300,000 gallons in 1914 to less than 40,000 gallons in 1915, the imports from Italy were slightly more than 30,000 gallons, and those from England and Spain were about 90,000 gallons.

Mineral waters imported into the United States, 1911–1915.

Year.	Quantity.	Value.	Price per gallon.
	Gallons.		*Cents.*
1911	3,604,703	$1,037,485	29
1912	3,499,497	930,091	27
1913	3,364,676	955,788	28
1914	2,786,142	857,707	31
1915	1,528,181	551,648	36

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MINERAL-WATER TRADE BY STATES.

ALABAMA.

Returns from Alabama indicate that the mineral-water trade in 1915 was little more than half that in 1914. The sales amounted to 86,499 gallons, and the value of the output was $8,912, the average price per gallon, 10 cents, remaining the same. The decrease was chiefly in sales of table waters. Fourteen springs reported sales; four springs regarding which no reports have been received for two years have necessarily been considered idle. Four mineral-water bathing establishments and five resorts accommodating about 650 guests were maintained. A small amount of mineral water also was used in the manufacture of soft drinks.

The following 14 springs reported sales:

Bailey Springs, Florence, Lauderdale County.
Bladon Springs, Bladon Springs, Choctaw County.
Bromberg Gulf Coast Lithia Spring, Bayou Labatre, Mobile County.
Cooks Springs, Cooks Springs, St. Clair County.
Dixie Spring, Dixie Spring, Walker County.
Healing Springs, Healing Springs, Washington County.
Ingram Lithia Well, near Ohatchee, Calhoun County.
Livingston Mineral Spring, Livingston, Sumter County.
Luverne Mineral Spring, Luverne, Crenshaw County.
McCary Mineral Well, near Birmingham, Jefferson County.
Matchless Mineral Wells, east of Greenville, Butler County.
Purity Spring, Spring Hill, Mobile County.
Shocco Spring, Talladega, Talladega County.
White Sulphur Wells, near Jackson, Clarke County.

ARKANSAS.

The sales of mineral water in Arkansas during 1915 increased nearly to the maximum of 1913 though five springs active in 1914 were reported idle in 1915.

Mineral waters sold in Arkansas, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	8	1,560,157	$118,994	8
1912	11	1,396,082	132,257	10
1913	16	1,428,869	151,412	11
1914	18	1,314,159	115,205	9
1915	13	1,377,093	119,072	9

Five resorts accommodating about 5,350 guests, exclusive of Hot Springs, and 3 bathing establishments were maintained, in addition to which 100,000 gallons of mineral water was used in the manufacture of soft drinks.

The 13 springs reporting sales are as follows:

Arsenic Spring, Hot Springs, Garland County.
Chewaukla Spring, Hot Springs, Garland County.
De Soto Springs, Hot Springs, Garland County.
Glenaqua Mineral Springs, Hot Springs, Garland County.
Happy Hollow Springs, Hot Springs, Garland County.
Iron and Magnesia springs, Hot Springs, Garland County.

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Mountain Blood Spring, near Hot Springs, Garland County.
Mountain Valley Springs, Mountain Valley, Garland County.
Oaklawn Mineral Well, Hot Springs, Garland County.
Ozarka Spring, Eureka Springs, Carroll County.
Park Springs, Bentonville, Benton County.
Potash Sulphur Springs, Lawrence, Garland County.
Raleigh Springs, Little Rock, Pulaski County.

CALIFORNIA.

The output of mineral water in California during 1915 showed an increase of 22 per cent in quantity and 7 per cent in value as compared with the output in 1914. The disproportionate increases in quantity and value are caused chiefly by increased sales of low-priced table waters and decreased sales of high-priced medicinal waters. Yet California ranked first in production of medicinal waters, third in value of table waters and total value of output, and tied Virginia for second rank in number of commercial springs in 1915.

Mineral waters sold in California, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	40	2,310,237	$578,439	25
1912	41	2,089,951	532,971	26
1913	49	2,801,393	531,925	19
1914	48	2,282,569	497,923	22
1915	50	2,789,871	532,817	19

Three new producers—Dollar Mountain Medical, Iaqua Medicinal, and Napa Rock springs—were added to the list; 2 springs active in 1914 were idle in 1915, 3 other springs active in 1914 were considered idle in 1915, and the output of 1 spring from which no report could be obtained has been estimated. Two springs temporarily idle in 1914 were active in 1915. The number of active springs was 50, or 2 more than in 1914. Napa Vichy Springs were formerly called Lepori Vichy Springs, McGlashan Mineral Spring was formerly called Tahoe Spring, and Shanghai Mineral Spring was formerly called Purity Springs. Mineral-water baths were maintained at 21 springs, and 24 resorts, accommodating nearly 7,000 guests, were operated. In the manufacture of soft drinks 94,000 gallons of mineral water was used.

The 49 springs reporting production are as follows:

Ætna Springs, Lidell, Napa County.
Agua Caliente Springs, Agua Caliente, Sonoma County.
Alder Glen Springs, Cloverdale, Sonoma County.
Alhambra Springs, Martinez, Contra Costa County.
Alma Spring, Alma, Santa Clara County.
Barcal Springs, Preston, Sonoma County.
Bartlett Spring, Bartlett Springs, Lake County.
Bimini Hot Spring, Los Angeles, Los Angeles County.
Boyes Hot Springs, Boyes Springs, Sonoma County.
Busch Springs, Potter Valley, Mendocino County.
Bythinia Springs, Santa Barbara, Santa Barbara County.
Calavichy Spring, Willits, Mendocino County.
California Geysers, The Geysers, Sonoma County.
Castalian Water, Keeler, Inyo County.
Castle Rock Springs, Eubanks, Shasta County.
Console Spring, Colton, Riverside County.

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Cooks Springs, near Williams, Colusa County.
Crystal Spring, Los Angeles, Los Angeles County.
Deerlick Springs, Deer Lick Springs, Trinity County.
Dollar Mountain Medical Springs, Lake County.
El Granito Spring, El Cajon, San Diego County.
Elliotta White Sulphur Spring, Riverside, Riverside County.
Elysian Spring, Los Angeles, Los Angeles County.
Holly Spring, Hollywood, Los Angeles County.
Iaqua Medicinal Spring, Eureka, Humboldt County.
Marin Mountain Spring, Sausalito, Marin County.
McGlashan Mineral Spring, near Truckee, Nevada County.
Mok-Hill Mineral Spring, Mokelumne Hill, Calaveras County.
Monterey Mineral Well, Monterey, Monterey County.
Napa Rock Spring, Soda Valley, Napa County.
Napa Rock Soda Springs, Napa Soda Springs, Napa County.
Napa Vichy Springs, near Napa, Napa County.
Nuvida Spring, La Presa, San Diego County.
Pope Mineral Spring, Pope Valley, Napa County.
Radium Sulphur Spring, Colegrove, Los Angeles County.
Redwing Springs, Middletown, Lake County.
Richardsons Springs, Chico, Butte County.
Rose Spring, Los Angeles, Los Angeles County.
San Benito Mineral Well, near Hollister, San Benito County.
Shanghai Mineral Spring, Sausalito, Marin County.
Shasta Springs, Shasta Springs, Siskiyou County.
Tamalpais Mineral Well, San Rafael, Marin County.
Tuscan Springs, Tuscan, Tehama County.
Upper Soda Spring, Dunsmuir, Siskiyou County.
Valley Springs, Valley Springs, Calaveras County.
Veronica Medicinal Springs, near Santa Barbara, Santa Barbara County.
Walters Springs, Pope Valley, Napa County.
Wheelers Hot Springs, Wheeler Springs, Ventura County.
Witter Medical Springs, Witter Springs, Lake County.

COLORADO.

Returns from Colorado indicate a decrease of 11 per cent in quantity and 44 per cent in value of mineral water sold in 1915 and a decrease in the average price from 12 cents in 1914 to 7 cents in 1915. This great decrease in value compared with quantity is caused chiefly by reduction in price of certain well-known table waters. The sales of table water constituted 90 per cent of the total value for the State in 1915.

Mineral waters sold in Colorado, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	14	1,436,066	$104,763	7
1912	11	1,178,308	75,314	6
1913	11	1,053,429	89,820	9
1914	12	988,260	113,413	12
1915	14	858,185	63,104	7

Reports of production were received for the first time from Seven Minutes Spring. One spring idle in 1914 was active in 1915, and another from which no report was received has been considered idle. Four bathing establishments and three resorts, which accommodated nearly 2,900 guests, were operated. In addition to the quantity of mineral water reported sold, 230,891 gallons was used in the manufacture of soft drinks.

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The 14 springs regarding which reports were received are as follows:

Boulder Springs, Boulder Springs, Boulder County.
Canon City Soda Spring, Canon City, Fremont County.
Clark Magnetic Mineral Spring, Pueblo, Pueblo County.
Columbia Well, Denver, Denver County.
Crystal Springs, Fowler, Otero County.
Green Mineral Well, Canon City, Fremont County.
Horn Mineral Spring, Colorado Springs, El Paso County.
Navajo, Shoshone, Manitou, and Cheyenne springs, Manitou, El Paso County.
Pueblo Mineral Spring, Pueblo, Pueblo County.
Seven Minutes Spring, Manitou, El Paso County.
Ute Chief Spring, Manitou, El Paso County.
Ute, Iron, Ouray, Little Chief, and Geyser springs, Manitou, El Paso County.
Waunita Hot Springs, Waunita Hot Springs, Gunnison County.
Yampah Spring, Glenwood Springs, Garfield County.

CONNECTICUT.

The mineral-water business in Connecticut decreased 24 per cent in quantity and in value during 1915, and the average price remained the same. As in 1914, there was a decrease in the sale of table water, particularly in the vicinity of New Haven. The value of medicinal waters sold was, however, more than double that for 1914.

Mineral waters sold in Connecticut, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	28	2,164,701	$182,744	8
1912	28	2,110,231	153,383	7
1913	43	2,458,327	136,878	6
1914	42	2,341,082	134,478	6
1915	38	1,774,213	101,970	6

Sales from Beach Spring were reported for the first time, and sales also were reported from 3 springs inactive in 1914. The production of 1 spring regarding which no report could be obtained was estimated and 2 were considered idle. Eight spring waters sold in 1914 were not on the market in 1915. Thus the number of active springs was 38. No resorts or mineral-water baths were reported, but about 320,000 gallons of mineral water was used in the manufacture of soft drinks.

The 37 springs for which production was reported are as follows:

Althea Spring, Waterbury, New Haven County.
Ansantawae Spring, Woodmont, New Haven County.
Arethusa Spring, Seymour, New Haven County.
Bailey Spring, Mill Plain, Fairfield County.
Barcla Spring, Danbury, Fairfield County.
Beach Spring, Middletown, Middlesex County.
Beaver Spring, Ansonia, New Haven County.
Berkshire Spring, Cornwall Bridge, Litchfield County.
Chalybeate Spring, Oxford, New Haven County.
Cherry Hill Spring, Highwood, New Haven County.
Crystal Spring, near Middletown, Middlesex County.
Crystal Spring, near Derby, New Haven County.
Diamond Spring, Cheshire, New Haven County.
East Hill Spring, Derby, New Haven County.

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Elco Spring, Bristol, Hartford County.
Ellis Mountain Spring, Danbury, Fairfield County.
Granite Rock Spring, Higganum, Middlesex County.
Granite Rock Spring, Danbury, Fairfield County.
Gra-Rock Spring, Canton, Hartford County.
Hermitage Spring, Montowese, New Haven County.
Highland Spring, near Mount Higbee, Middlesex County.
Hillside Spring, West Meriden, New Haven County.
Hosmer Mountain Spring, Willimantic, Windham County.
Live Oak Spring, Meriden, New Haven County.
Mammanasco Spring, Ridgefield, Fairfield County.
Mountainville Spring, Danbury, Fairfield County.
Oak Spring, Middletown, Middlesex County.
Park Spring, Willimantic, Windham County.
Pequabuck Mountain Spring, Bristol, Hartford County.
Pequot Mineral Spring, Old Mystic, New London County.
Pine Spring, Wallingford, New Haven County.
Red Rock Spring, Meriden, New Haven County.
Richardson Spring, Torrington, Litchfield County.
Stafford Mineral Springs, Stafford Springs, Tolland County.
Tonica Spring, Highland Park, Hartford County.
Varuna Spring, North Stamford, Fairfield County.
Venture Rock Spring, Stonington, New London County.

DELAWARE.

Reports have been received from only one spring in Delaware during the last five years, the water being used chiefly on the table by residents of Wilmington. The spring is called:

Kiamensi Spring, near Wilmington, Newcastle County.

FLORIDA.

The output of mineral water in Florida during 1915 showed a decrease in quantity and value of 49 per cent as compared with that in 1914. Four springs active in 1914 were idle in 1915. The total production was 118,920 gallons, valued at $12,516, as compared with 231,160 gallons, valued at $24,738, in 1914. The average price per gallon, 11 cents, remained the same.

The number of active springs is 7, as follows:

Chumuckla Mineral Spring, Chumuckla, Santa Rosa County.
Espiritu Santo Spring, Safety Harbor, Pinellas County.
Lackawanna Spring, near Jacksonville, Duval County.
Magnesia Spring, Grove Park, Alachua County.
Purity Spring, Tampa, Hillsboro County.
Quisisana Spring, Green Cove Springs, Clay County.
Stomawa Well, near Tampa, Hillsboro, County.

GEORGIA.

The sales of mineral water in Georgia increased 14 per cent in quantity and 8 per cent in value during 1915, and the price per gallon dropped from 8 to 7 cents. The production was 746,068 gallons, valued at $53,779, as compared with 652,566 gallons, valued at $49,659, in 1914. The increase in output of table waters is marked. Three bathing establishments and 3 resorts accommodating 700 guests were maintained at springs. Reports from Cliff Rock, Flake Hill, and Windsor springs, and High Point Mineral Well were received for the first time, and 4 waters heretofore on the market were not

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sold; thus the number of active springs remained 19, the names and locations of which are given in the appended list:

Benscot Mineral Springs, Austell, Cobb County.
Bowden Lithia Spring, Lithia Springs, Douglas County.
Catoosa Springs, Catoosa Springs, Catoosa County.
Chalybeate Springs, Chalybeate, Meriwether County.
Cliff Rock Spring, Fulton County.
Daniel Mineral Spring, Union Point, Greene County.
Flake Hill Spring, Debruce, Richmond County.
High Point Mineral Well, Macon, Bibb County.
High Rock Spring, near Atlanta, Fulton County.
Holly Springs, Hollysprings, Cherokee County.
Jay Bird Spring, near Helena, Dodge County.
Miller's Mineral Spring, Milledgeville, Baldwin County.
Murrow Spring, Tifton, Tift County.
Panther Spring, near Augusta, Richmond County.
Pine Mountain Spring, West Point, Harris County.
Swift Lithia Spring, Elberton, Elbert County.
White Elk Spring, Macon, Bibb County.
White Oak Mineral Wells, Macon, Bibb County.
Windsor Spring, near Augusta, Richmond County.

ILLINOIS.

The mineral-water business in Illinois decreased 11 per cent in quantity and 7 per cent in value during 1915. There was a noticeable decline in the output of table water.

Mineral waters sold in Illinois, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	14	1,304,950	$82,330	6
1912	17	1,143,625	74,445	7
1913	21	1,216,442	68,549	6
1914	21	1,760,030	81,307	5
1915	23	1,559,489	75,290	5

Production was reported for the first time from Ams Well and Marilla, Stabler's Medicinal, and Tus-Ka-Walla springs. Two waters sold in 1914 were not on the market in 1915. The number of active springs was thus increased to 23. In addition to the quantity reported sold nearly 268,000 gallons of mineral water was used in the manufacture of soft drinks. Resorts for nearly 700 guests were maintained at 5 springs, and mineral-water bathing establishments were maintained at 9 springs.

Sales were reported from the following 23 springs:

Abana Mineral Springs, Libertyville, Lake County.
Ams Well, Alton, Madison County.
Central Park Sulphur Spring, Peoria, Peoria County.
Cumberland Spring, Greenup, Cumberland County.
Glen Flora Mineral Spring, Waukegan, Lake County.
Glen Rock Mineral Spring, Waukegan, Lake County.
Gravel Spring, near Jacksonville, Morgan County.
Indian Spring, Streator, Lasalle County.
Macinac Mineral Springs, near Carlock, Woodford County.
Marilla Spring, Streator, Lasalle County.
Minerva Spring, Cary Station, McHenry County.

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Mokena Mineral Spring, Mokena, Will County.
Montgomery Magnesia Spring, Montgomery, Kane County.
Namonomia and Old Ironsides springs, Dixon Springs, Pope County.
Pekin Mineral Spring, Pekin, Tazewell County.
Perry Mineral Spring, Perry, Pike County.
Ripley Mineral Spring, Cooperstown, Brown County.
Sanicula Spring, South Ottawa, Lasalle County.
Stabler's Medicinal Spring, Kewanee, Henry County.
Sulphur Lick Spring, Wedron, Lasalle County.
Tus-Ka-Walla Spring, Cordova, Rock Island County.
Woodmen Artesian Well, Rock Island, Rock Island County.

INDIANA.

Eighteen springs in Indiana had an output of 542,053 gallons of mineral water, valued at $189,074, in 1915, whereas the output in 1914 was only 382,247 gallons, valued at $138,118. This remarkable increase in quantity of 42 per cent and in value of 37 per cent was caused by increased sales of both medicinal and table waters, as the average price per gallon was reduced only from 36 to 35 cents.

Artesian Mineral and Greenwood springs are new producers; 2 producers in 1914 were idle in 1915; 1 spring idle in 1914 was a producer in 1915. Blue Lick Spring is now known as Paynes Saline Sulphur Spring. More than half the production is sold for medicinal use. There are resorts at 7 springs for nearly 2,000 guests, and the mineral water is used for bathing at 7 springs. Very little mineral water is used in Indiana for manufacturing soft drinks.

The following 18 springs have reported sales:

Artesian Mineral Spring, Martinsville, Morgan County.
Blue Cast Spring, Woodburn, Allen County.
Bronson Spring, Terre Haute, Vigo County.
Carlson Mineral Springs, Laporte, Laporte County.
Cartersburg Mineral Springs, Cartersburg, Hendricks County.
Coats Spring, Littles, Pike County.
Colomagna Springs, Columbus, Bartholomew County.
Greenwood Springs, Fort Wayne, Allen County.
Holman Mineral Well, Crawfordsville, Montgomery County.
Knotts Mineral Spring, Porter, Porter County.
McCullough Spring, Oakland City, Gibson County.
Martinsville Spring, Martinsville, Morgan County.
Paoli Lithia Spring, Paoli, Orange County.
Paynes Saline Sulphur Spring, Henryville, Clark County.
Pluto, Proserpine, and Bowles springs, French Lick, Orange County.
Reid Mineral Spa Lithia Spring, near Richmond, Wayne County.
West Baden Mineral Springs, West Baden, Orange County.
White Crane Spring, Dillsboro, Dearborn County.

IOWA.

According to returns the output of mineral water in Iowa during 1915 was 198,739 gallons, sold for $18,534, as compared with 303,827 gallons, sold for $30,179, in 1914. These figures correspond to decreases in quantity and value, respectively, of 35 and 39 per cent. The average price per gallon dropped from 10 to 9 cents. One spring idle in 1914 was active in 1915. Colfax Grand Spring was formerly called Grand Hotel Mineral Spring. Two-thirds of the water was sold for table use, and in addition more than 150,000 gallons of mineral water was used in the manufacture of soft drinks. One mineral-water bathing establishment and 2 resorts were maintained.

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The 8 springs reporting sales are as follows:

Colfax Mineral Spring, Colfax, Jasper County.
Colfax Grand Spring, Colfax, Jasper County.
Crystal Spring, Estherville, Emmet County.
Egralharve Spring, Montgomery, Dickinson County.
Hawkeye Hygeia Spring, Sioux City, Woodbury County.
Hestons Spring, Jefferson County.
Red Mineral Springs, Eddyville, Wapello County.
White Sulphur Spring, near Davenport, Scott County.

KANSAS.

The output of mineral water in Kansas during 1915 showed a decrease in quantity but an increase in value, the total sales amounting to 155,938 gallons, valued at $63,069, as compared with 272,722 gallons, valued at $56,440, in 1914. This corresponds to a decrease in output of 43 per cent, an increase in value of 12 per cent, and a consequent increase in the average price per gallon from 21 to 40 cents. This rise is due chiefly to increased sales of medicinal waters. Nature's Best Spring is a new producer. Two springs active in 1914 were idle in 1915. Resorts with mineral-water bathing establishments accommodated nearly 300 guests at 3 springs, and in addition mineral-water bathing establishments were maintained at 2 other springs.

The following 14 springs reported sales:

AbilenA Wells, Abilene, Dickinson County.
Aganippe Spring, near Independence, Montgomery County.
Blasing's Mineral Spring, near Manhattan, Riley County.
California Spring, Ottawa, Franklin County.
Crystal Well, Coffeyville, Montgomery County.
Geyser Mineral Springs, Rosedale, Wyandotte County.
Magnesium and Choteau springs, Independence, Montgomery County.
Nature's Best Spring, Conway Springs, Sumner County.
Phillips's Mineral Spring, Topeka, Shawnee County.
Riverview Mineral Springs, Winfield, Cowley County.
Sun Springs, Morrill, Brown County.
Sycamore Springs, Sabetha, Brown County.
Viola Spring, near Viola, Sedgwick County.
Waconda Springs, Waconda Springs, Mitchell County.

KENTUCKY.

The mineral-water business in Kentucky has been about the same for the last four years. The reported sales in 1915 were 459,841 gallons, as compared with 437,334 gallons in 1914, an increase of 5 per cent, and the value of the output was $63,278, as compared with $56,494 in 1914, an increase of 12 per cent. The average price increased from 13 to 14 cents. Three-fourths of the production is sold for medicinal use. Avon-More and Richards mineral wells were added to the list of producers. Reports could not be obtained from 6 springs, and as several of them had been nonproductive two or more years it was necessarily assumed that they were no longer on the market. Lexington Lithia Springs are now known as Cole's Lexington Lithia Springs. Four resorts, accommodating more than 2,100 guests, inclusive of the capacity of Dawson Springs, and 2 mineral-water bathing establishments were maintained. In addition to this more than 185,000 gallons of mineral water was used in making soft drinks.

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The 11 springs reporting production are as follows:

Anita Spring, La Grange, Oldham County.
Avon-More Well, Dry Ridge, Grant County.
Cole's Lexington Lithia Springs, Lexington, Fayette County.
Glen Lily Lithia Wells, near Bowling Green, Warren County.
Hamby's Spring, Dawson Springs, Hopkins County.
Kentucky Carlsbad Spring, Dry Ridge, Grant County.
Kentucky Mineral Well, Lorain, Taylor County.
Knollwood Well, Bowling Green, Warren County.
Richards Mineral Well, South Bowling Green, Warren County.
Robson Spring, Fort Thomas, Campbell County.
Royal Magnesian Spring, near La Grange, Oldham County.

LOUISIANA.

A total output 11 per cent less in quantity and 3 per cent less in value than in 1914 was reported from 5 springs in Louisiana also active in 1913 and 1914. Seven-eighths of the water was sold for table use.

Mineral waters sold in Louisiana, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	5	1,520,550	$110,998	7
1912	4	561,660	33,345	6
1913	5	700,795	39,657	6
1914	5	576,138	31,562	6
1915	5	513,838	30,771	6

One resort for guests but no mineral-water bathing establishment was operated. One spring unreported in 1914 and idle in 1913 was considered idle in 1915.

The 5 springs that made returns are as follows:

Abita Springs, Abita Springs, St. Tammany Parish.
Geyser Spring, Hammond, Tangipahoa Parish.
Greenwell Spring, Magnolia, East Baton Rouge Parish.
Krotz Spring, Krotz Springs, St. Landry Parish.
Ozone Spring, Pearl River, St. Tammany Parish.

MAINE.

The production of mineral water in Maine was about the same in 1915 as in 1914, though the number of active springs was reduced from 29 to 24. The average price per gallon dropped 1 cent. The consumption of mineral water in the manufacture of soft drinks dropped from nearly 190,000 gallons in 1914 to less than 40,000 gallons in 1915.

Mineral waters sold in Maine, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	28	1,254,783	$431,740	34
1912	31	1,179,192	432,765	37
1913	32	1,174,262	368,436	31
1914	29	1,082,631	333,234	31
1915	24	1,115,648	338,003	30

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One large resort for guests but no bathing establishment using mineral water was operated. Two springs unreported in both 1914 and 1915, 1 spring unreported in 1915 and reported idle in 1914, and 2 small springs active in 1914 but unreported in 1915 have been considered idle in 1915. The names and locations of the 24 springs regarding which reports were received are given in the following list:

Arctic Spring, Bangor, Penobscot County.
Bakers Puritan Spring, Pine Point, Cumberland County.
Blue Hill Mineral Spring, Blue Hill, Hancock County.
Forest Springs, Litchfield, Kennebec County.
Glenrock Cold Spring, Greene, Androscoggin County.
Glenwood Spring, Augusta, Kennebec County.
Glenwood Mineral Spring, St. Albans, Somerset County.
Hanover Spring, Hanover, Oxford County.
Highland Spring, Lewiston, Androscoggin County.
Indian Hermit Spring, Wells, York County.
Kennebunk Mineral Spring, Kennebunkport, York County.
Keystone Mineral Spring, East Poland, Androscoggin County.
Mount Desert Spring, Northeast Harbor, Hancock County.
Mount Zircon Spring, Milton Plantation, Oxford County.
Mystic Spring, Saco, York County.
Oak Grove Spring, Brewer, Penobscot County.
Poland Mineral Spring, South Poland, Androscoggin County.
Purity Spring, West Scarboro, Cumberland County.
Redman Farm Spring, Belfast, Waldo County.
Rocky Hill Spring, Fairfield, Somerset County.
Sabattus Mineral Spring, Sabattus, Androscoggin County.
Skowhegan Crystal Spring, Skowhegan, Somerset County.
Thorndike Mineral Spring, near Thorndike, Waldo County.
Wawa Lithia Spring, Ogunquit, York County.

MARYLAND.

Returns from Maryland for 1915 indicate a decline of 15 per cent in both quantity and value of mineral water sold. The output is entirely table water, much of which is sold in Baltimore. In addition to the quantity reported as sold, 120,000 gallons was used in the manufacture of soft drinks.

Mineral waters sold in Maryland, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	12	1,657,756	$150,966	9
1912	13	1,606,373	157,541	10
1913	12	1,390,437	126,883	9
1914	10	1,691,776	124,403	7
1915	10	1,433,406	105,581	7

Big Rock and Brooklandwood springs are new producers. Two springs that were active in 1914 were idle in 1915, and 1 other spring on which no report has been received for two years has been considered idle. Thus the number of active springs has remained the same. Two resorts for guests were maintained.

The 10 springs reporting sales are as follows:

Altamont Spring, near Deer Park, Garrett County.
Big Rock Spring, Frederick County.

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Brooklandwood Spring, Brooklandville, Baltimore County.
Buena Vista Spring, Edgemont, Washington County.
Carroll Springs, Forest Glen, Montgomery County.
Caton Spring, Catonsville, Baltimore County,
Chattolanee Spring, Chattolanee, Baltimore County.
Mardela Mineral Spring, Mardela Springs, Wicomico County.
Powhatan Spring, Baltimore, Baltimore County.
Rock Crystal Spring, Rognel Heights, Baltimore County.

MASSACHUSETTS.

Massachusetts ranked first among the States in consumption of mineral water for the manufacture of soft drinks, fourth in number of producing springs, and fifth in value of table waters in 1915. The mineral-water business in Massachusetts increased 26 per cent in quantity and 6 per cent in total value. The great increase in sales without corresponding increase in value was caused by a decline in marketing high-priced table waters and a great increase in marketing low-priced table waters, as a consequence of which the average price per gallon decreased from 6 to 5 cents.

Mineral waters sold in Massachusetts, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	56	4,610,474	$218,870	5
1912	54	4,502,806	247,397	6
1913	60	3,907,395	213,802	6
1914	52	3,084,385	174,324	6
1915	48	3,872,192	184,133	5

No new spring waters were placed on the market. Three springs failed to report in both 1914 and 1915, and 3 springs reported idle in 1914 and not reporting in 1915 have been considered idle. Three other springs reported active in 1914 were idle in 1915. In addition to the mineral water sold 876,000 gallons was used in the manufacture of soft drinks. One small resort and 1 mineral-water bathing establishment were maintained.

The 48 reporting springs are as follows:

Abbott Spring, Methuen, Essex County.
Ballardvale Spring, Ballardvale, Essex County.
Belmont Crystal Spring, Belmont, Middlesex County.
Burnham Spring, Methuen, Essex County.
Cadwells Crystal Spring, Woburn, Middlesex County.
Chapmans Crystal Spring, Stoneham, Middlesex County.
Chelmsford Spring, Chelmsford, Middlesex County.
Chickatawbut Spring, Hingham, Plymouth County.
Cochato Spring, South Braintree, Norfolk County.
Crystal Spring, West Peabody, Essex County.
Deep Glen Spring, West Lynn, Essex County.
El-Azhar Spring, Tyngsboro, Middlesex County.
Goulding Spring, Whitman, Plymouth County.
Granite Rock Spring, Brockton, Plymouth County.
Great Radium Spring, Pittsfield, Berkshire County.
Holyoke Spring, West Lynn, Essex County.
Indian Spring, Brockton, Plymouth County.
King Philip Spring, Mattapoisett, Plymouth County.

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Klines Spring, Lawrence, Essex County.
Leicester Polar Spring, Spencer, Worcester County.
Milton Spring, Milton, Norfolk County.
Mount Blue Mineral Spring, Hingham, Plymouth County.
Mount Holyoke Lithia Spring, South Hadley, Hampshire County.
Mount Pleasant Spring, Lowell, Middlesex County.
Mount Vernon Spring, Lawrence, Essex County.
Nemasket Spring, Middleboro, Plymouth County.
New Abbott Spring, Methuen, Essex County.
Nobscot Mountain Spring, Framingham, Middlesex County.
Norwood Spring, Norwood, Norfolk County.
October Spring, Lenox, Berkshire County.
Pearl Hill Spring, Fitchburg, Worcester County.
Pepperell Spring, Pepperell, Middlesex County.
Pequot Mineral Spring, North Natick, Middlesex County.
Pocahontas Spring, Lynnfield Center, Essex County.
Puritan Spring, Andover, Essex County.
Purity Spring, Danvers, Essex County.
Purity Spring, Chelmsford, Middlesex County.
Robbins Springs, Arlington Heights, Middlesex County.
Sand Spring, Williamstown, Berkshire County.
Shawmut Spring, West Quincy, Norfolk County.
Simpson Spring, South Easton, Bristol County.
Sippican Spring, Marion, Plymouth County.
Sterling Spring, West Lynn, Essex County.
Stevens Spring, Lawrence, Essex County.
Twin Elm Spring, Lexington, Middlesex County.
Valpey Spring, Lawrence, Essex County.
Whitman Spring, Whitman, Plymouth County.
Ye Cape Cod Pilgrim Spring, South Wellfleet, Barnstable County.

MICHIGAN.

The total mineral-water business in Michigan during 1915 was nearly the same as during 1914, but sales of medicinal waters were less than half those in 1914, and the sales of table waters increased to an equivalent amount.

Mineral waters sold in Michigan, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	19	1,713,401	$72,253	4
1912	18	1,420,465	75,611	5
1913	20	884,893	52,642	6
1914	22	931,343	70,310	8
1915	19	913,765	72,711	8

Production was reported from Silver Spring for the first time; 1 spring idle in 1914 was active in 1915; the output of 1 spring for which no report could be obtained was estimated, and that of another not reported was necessarily considered zero. Three springs active in 1914 were reported idle in 1915; 1 spring idle in 1914 was not reported in 1915 and has been considered idle; thus the number of active springs decreased from 22 to 19. Four resorts accommodating 1,650 guests and 1 mineral-water bathing establishment were maintained at springs. In addition to the mineral water sold about 145,000 gallons, as in 1914, was used in the manufacture of soft drinks.

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The 18 springs reporting sales are as follows:

Andrews Magnetic Mineral Spring, St. Louis, Gratiot County.
Arctic Spring, Grand Rapids, Kent County.
Bailey Marvel Spring, between Bellaire and Alden, Antrim County.
Beard Hills Spring, Atkins, St. Clair County.
Beaver Springs, Bangor, Van Buren County.
Crystal Springs, Grand Rapids, Kent County.
Eastman Springs, Benton Harbor, Berrien County.
Eureka Spring, Mount Clemens, Macomb County.
Lake Superior Mineral Spring, Marquette, Marquette County.
Ogemaw Spring, Maltby, Ogemaw County.
Panacea Spring, Mount Clemens, Macomb County.
Ponce de Leon Spring, Paris Township, Kent County.
Sanitas Spring, Topinabee, Cheboygan County.
Silver Spring, Northville, Wayne County.
Spring Hill Spring, South Haven, Van Buren County.
Sterling Spring, Crystal Falls, Iron County.
Sultana Spring, near Hartford, Van Buren County.
Victory Spring, Mount Clemens, Macomb County.

MINNESOTA.

Reported sales of mineral water in Minnesota showed a decrease of 38 per cent in quantity and 30 per cent in value during 1915. The sales decreased markedly in the vicinity of the Twin Cities. The average price per gallon, which fell from 4 cents in 1913 to 3 cents in 1914, rose again to 4 cents in 1915. Practically all the water was sold for table use.

Mineral waters sold in Minnesota, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	17	8,703,319	$270,039	3
1912	18	8,881,018	252,277	3
1913	16	4,802,058	183,759	4
1914	15	5,639,232	194,041	3
1915	17	3,493,887	136,259	4

Reports of production were received for the first time from Ogahmah and Rosendale springs. One spring active in 1914 but unreported in 1915 was necessarily considered idle, and 1 spring considered idle in 1914 reported production in 1915. One resort for guests and 1 mineral-water bathing establishment were operated at springs. In addition to the quantity reported as sold 435,601 gallons was used in the manufacture of soft drinks.

The 17 springs for which production was reported are as follows:

Campbells Spring, Fergus Falls, Ottertail County.
Clear Spring, Excelsior, Hennepin County.
Deep Spring, Crookston, Polk County.
Glenwood-Inglewood Spring, Minneapolis, Hennepin County.
Highland Spring, St. Paul, Ramsey County.
Indian Medical Spring, Elk River, Sherburne County.
Mankato Mineral Springs, near Eagle Lake, Blue Earth County.
Ogahmah Spring, Thief River Falls, Pennington County.
Owens Spring, Glenwood, Pope County.
Pokegama Spring, near Detroit, Becker County.
Red Star Spring, Cold Spring, Stearns County.
Rock Spring, Shakopee, Scott County.

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Rosendale Spring, St. James, Watonwan County.
Silver Spring, Marshall, Lyon County.
Silver Spring, Ortonville, Bigstone County.
Trio Siloam Spring, Austin, Mower County.
Ward Springs, Ward Springs, Todd County.

MISSISSIPPI.

There was a notable decrease in the mineral-water business in Mississippi during 1915, the sales reported being 259,370 gallons, practically all classed as medicinal water, valued at $45,639, as compared with 415,904 gallons, valued at $73,068, in 1914. These figures correspond to decreased quantity and value of 38 per cent. The price per gallon, 18 cents, remained the same. Three springs temporarily idle in 1914 were producing in 1915, and 1 spring idle in 1914 and unreported in 1915 was necessarily considered idle. No new springs were reported to be active. Two mineral-water bathing establishments and 7 resorts, accommodating 1,200 guests, were maintained at springs. Production was reported for the first time for Owens Well.

The names of the 11 springs reported active in 1915 follow:

Allison's Wells, Way, Madison County.
Browns Wells, near Hazlehurst, Copiah County.
Butler Spring, near Oxford, Lafayette County.
Castalian Spring, near Durant, Holmes County.
Cooper's Well, Raymond, Hinds County.
Madison Springs, Pocahontas, Madison County.
Morris Mineral Spring, Vosburg, Jasper County.
Owens Well, Owens, Holmes County.
Red Springs, Stewart, Choctaw County.
Robinson Springs, Madison County, near Pocahontas.
Stafford Mineral Springs, Vosburg, Jasper County.

MISSOURI.

There was a marked increase in the quantity of mineral water from Missouri sold during 1915. The reported production increased 72 per cent in quantity and 12 per cent in value. The chief cause of this increase was greater demand for several well-known waters reputed to have medicinal value. The average price per gallon dropped from 13 to 8 cents. Nearly 80 per cent of the water is said to be used medicinally.

Mineral waters sold in Missouri, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	25	542,892	$86,747	16
1912	30	608,385	81,114	13
1913	34	697,467	84,316	12
1914	36	583,288	74,793	13
1915	33	1,000,961	83,363	8

Fonzo and Park springs were reported for the first time as active producers, one spring considered idle and 1 spring reported idle in 1914 were reported active in 1915, and 7 springs active in 1914 were reported idle in 1915. Six resorts, exclusive of those at Excelsior Springs, and 6 mineral-water bathing establishments were

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operated. A small amount of mineral water also was used in the manufacture of soft drinks.

The following 33 springs made returns of sales:

Bowling Green B. B. Springs, Bowling Green, Pike County.
Belcher Artesian Well, St. Louis, St. Louis City County.
Blue Lick Springs, Blue Lick, Saline County.
Bokert Springs, near De Soto, Jefferson County.
Chouteau Springs, near Boonville, Cooper County.
Crystal Spring, Excelsior Springs, Clay County
Cusenbery Spring, Mount Washington, Jackson County.
Excelsior Saline Spring, Excelsior Springs, Clay County.
Fonzo Springs, Bowling Green, Pike County.
Grand River Mineral Spring, near Mercer, Mercer County.
Haymaker Spring, Mercer County, near Lineville, Iowa.
Jackson Lithia Spring, Mount Washington, Jackson County.
Kalinat Bitter and Ionian Lithia springs, Bowling Green, Pike County.
Lithia No. 1 Spring, Excelsior Springs, Clay County.
McAllister Springs, near Houstonia, Saline County.
Mee Soda Well, Excelsior Springs, Clay County.
Musick Spring, Eldorado Springs, Cedar County.
Natrona Soda Spring, Excelsior Springs, Clay County.
Nek-Rok Spring, Burlington Junction, Nodaway County.
Old Orchard Spring, Old Orchard, St. Louis County.
Paris Springs, Paris Springs, Lawrence County.
Park Spring, Eldorado Springs, Cedar County.
Regent, Siloam, Soterian, and Sulpho-Saline springs, Excelsior Springs, Clay County.
Salax Spring, Excelsior Springs, Clay County.
Salt Sulphur Well, Excelsior Springs, Clay County.
Soda Saline Spring, Excelsior Springs, Clay County.
Sweet Springs, Sweet Springs, Saline County.
White Springs, Independence, Jackson County.
Wyaconda and La Grange springs, La Grange, Lewis County.

MONTANA.

The production of 3 springs reporting from Montana was somewhat greater in 1915 than in 1914. The sales in 1915 amounted to 114,245 gallons, valued at $6,603, whereas the sales in 1914 amounted to 100,700 gallons, valued at $5,555. This represents an increase of 14 per cent in quantity and 19 per cent in value. Mineral-water bathing establishments were maintained at 2 of these springs. Practically all the water was sold for table use.

The 3 active springs are as follows:

Lissner Mineral Spring, Helena, Lewis and Clark County.
Rock Creek Spring, Red Lodge, Carbon County.
White Sulphur Spring, White Sulphur Springs, Meagher County.

NEBRASKA.

The total production of 3 springs in Nebraska, also active in 1914, was reported for 1915 as 8,770 gallons, valued at $962, or at an average price of 11 cents a gallon. The production of the same springs in 1914 was 10,900 gallons, valued at $1,490. A mineral-water bathing establishment was maintained at 1 spring, and in addition to the mineral water reported sold about 70,000 gallons was used in the manufacture of soft drinks.

The names of the 3 springs reporting are as follows:

Brown Park Mineral Spring, South Omaha, Douglas County.
Curo Mineral Spring, South Omaha, Douglas County.
Shogo Lithia Spring, Milford, Seward County.

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NEVADA.

From 3 springs in Nevada was marketed 303,150 gallons of table water, valued at $4,294, in 1915. The production of the same springs in 1914 was 221,942 gallons, valued at $3,191. The average price per gallon in both years was slightly more than 1 cent. The increase in sales is equivalent to 37 per cent in quantity and 35 per cent in value. A small quantity of mineral water was used in the manufacture of soft drinks.

Reports were received from the following 3 springs:

Diamond Mineral Spring, Reno, Washoe County.
Ruby Spring, Halleck, Elko County.
Shoshone Spring, Franktown, Washoe County.

NEW HAMPSHIRE.

Returns from New Hampshire indicate a decrease of 9 per cent in quantity and 43 per cent in value of mineral water marketed in 1915. The total production in 1915 was 176,385 gallons, valued at $6,737, as compared with 194,418 gallons, valued at $11,731, in 1914. The average price per gallon dropped from 6 to 4 cents. The cause of this readjustment of the trade was decrease in sales and in price of several waters. Two springs from which no report could be obtained have necessarily been considered idle, and 1 spring that was idle in 1914 was active in 1915. No new springs were reported. About 120,000 gallons of mineral water in addition to that already noted was used in the manufacture of soft drinks.

The 7 springs reporting are as follows:

Crystal Spring, East Concord, Merrimack County.
Granite State Springs, Plaistow, Rockingham County.
Laconia Spring, The Weirs, Belknap County.
Lafayette Mineral Spring, Derry, Rockingham County,
White Mountain Mineral Spring, Conway, Carroll County.
Willow Spring, South Nashua, Hillsboro County.
Wilton Mineral Spring, near Wilton, Hillsboro County.

NEW JERSEY.

The sales of mineral water in New Jersey during 1915 showed a decrease of 14 per cent in quantity and 25 per cent in value, as compared with those in 1914. A similar decrease occurred in 1913 and 1914. The average price per gallon dropped to 8 cents.

Mineral waters sold in New Jersey, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	12	2,233,627	$210,123	9
1912	12	2,386,217	209,726	9
1913	14	2,067,277	188,546	9
1914	17	1,710,030	155,649	9
1915	13	1,479,479	116,226	8

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No new springs were reported; 4 springs active in 1914 were reported as nonproductive in 1915; thus the number of active springs has been reduced to 13. Practically the entire output was sold for table use, and, in addition, about 27,000 gallons of mineral water was used in the manufacture of soft drinks. No resort or mineral-water baths were maintained.

The following 13 springs reported sales:

Alpha Spring, Springfield, Union County.
Belmar Spring, Glen Rock, Bergen County.
Cold Indian Spring, Asbury Park, Monmouth County.
Culm Rock Spring, Pluckemin, Somerset County.
Echo Spring, Ewing (near Trenton), Mercer County.
Fairholme Spring, Wenonah, Gloucester County.
Grey Rock Spring, Trenton, Mercer County.
Indian Spring, near Rockaway, Morris County.
Kalium Spring, Collingswood, Camden County.
Kanouse-Oakland Spring, Oakland, Bergen County.
Pilgrim Spring, Ridgefield Park, Bergen County.
Rock Spring, West Orange, Essex County.
Watchung Spring, North Plainfield, Somerset County.

NEW MEXICO.

The production of 4 springs in New Mexico during 1915 was 42,400 gallons, valued at $6,680, as compared with 41,000 gallons, valued at $6,600, during 1914. The price per gallon remained 16 cents. More than two-thirds of this water is reported to have been sold for medicinal use. One small resort and 1 mineral-water bathing establishment were maintained. One spring from which no report has been received for two years has been considered idle.

The 4 springs for which production was reported are as follows:

Aztec Mineral Spring, Taylor Springs, Colfax County.
Carlsbad Springs, Carlsbad, Eddy County.
Coyote Springs, Albuquerque, Bernalillo County.
Ojo Caliente Spring, Ojo Caliente, Taos County.

NEW YORK.

The State of New York in 1915 ranked first in number of active mineral springs and in total production, second in total value of production and in value of table waters, and fifth in consumption of mineral water for the manufacture of soft drinks. Comparison of figures for 1915 with those for 1914 shows an increase of 3 per cent in quantity and 6 per cent in total value during 1915. The additional quantity used in manufacturing soft drinks was 340,976 gallons.

Mineral waters sold in New York, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	51	10,245,261	$939,003	9
1912	57	10,008,801	1,034,477	10
1913	64	9,801,255	871,601	9
1914	69	8,201,202	672,913	8
1915	75	8,411,616	711,697	8

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Six new producers, Cold, Nunda Mineral, Orenda, Saratoga Soft Sweet, Wawbeek, and White Bear springs, reported sales for the first time. One spring active in 1914 was idle in 1915, and 2 springs temporarily idle in 1914 were active in 1915. Six springs not reporting for two years or idle in 1914 and not reporting in 1915 have necessarily been considered idle in 1915. One spring formerly reported as in New York has been transferred to Vermont. The name of Real Rock Spring has been changed to Deep Rock and that of Adirondack Carrier Spring to Carrier Spring. Nine-tenths of the water is sold for table use. Four resorts, exclusive of those at Saratoga Springs, accommodated 3,400 guests, and mineral-water bathing establishments were operated at 4 springs during 1915.

The list of 75 commercial springs in 1915 is as follows:

Arlington Spring, Arlington, Dutchess County.
Arrowhead Spring, Weedsport, Cayuga County.
Artesian Lithia Spring, Ballston Spa, Saratoga County.
Baldwin Mineral Spring, Cayuga, Cayuga County.
Black Rock Spring, Rensselaer, Rensselaer County.
Breesport Oxygenated Mineral Spring, Breesport, Chemung County.
Briarcliff Spring, Briarcliff Manor, Westchester County.
Carrier Spring, Potsdam, St. Lawrence County.
Cascadian Spring, Nyack, Rockland County.
Cassadaga Spring, Lilly Dale, Chatauqua County.
Chemung Spring, Chemung, Chemung County.
Clinton Lithia Spring, Franklin Springs, Oneida County.
Coesa Spring, Saratoga Springs, Saratoga County.
Cold Spring, Utica, Oneida County.
Comstock Mineral Spring, Ballston Spa, Saratoga County.
Crystal Spring, Crystal Dale, Lewis County.
Crystal Springs, near Oswego, Oswego County.
Deep Rock Spring, Breesport, Chemung County.
Deep Rock Spring, Oswego, Oswego County.
Diamond Rock Spring, Lancaster, Erie County.
Dietade Mineral Spring, Keeseville, Essex County.
Eagle Spring, Edgewood, Greene County.
Elixir Spring, Clintondale, Ulster County.
Elk Spring, Lancaster, Erie County.
Flint Spring, West Sand Lake, Rensselaer County.
Franklin Lithia Spring, Franklin Springs, Oneida County.
Gardner White Sulphur Springs, Sharon Springs, Schoharie County.
Geneva Mineral Spring, Geneva, Ontario County.
Geyser Spring, Saratoga Springs, Saratoga County.
Glen Alex Spring, Washington Mills, Oneida County.
Gramatan Spring, Bronxville, Westchester County.
Granite Spring, Granite Springs, Westchester County.
Great Bear Spring, near Fulton, Oswego County.
Greendale Crystal Spring, Hudson, Columbia County.
Hathorn No. 1 Spring, Saratoga Springs, Saratoga County.
Hathorn No. 2 Spring, Saratoga Springs, Saratoga County.
Kirkland Mineral Spring, Franklin Springs, Oneida County.
Lithia Polaris Spring, near Boonville, Oneida County.
Madrid Indian Mineral Spring, Madrid Springs, St. Lawrence County.
Mammoth and Ideal springs, North Greenbush, Rensselaer County.
Minnonebe Spring, Saratoga Springs, Saratoga County.
Mohawk Springs, Amsterdam, Montgomery County.
Mohican Spring, Ballston Spa, Saratoga County.
Mokobo Spring, Mount Kisco, Westchester County.
Monarch Spring, Matteawan, Dutchess County.
Mount Beacon Spring, Beacon, Dutchess County.
Mount View Spring, Poughkeepsie, Dutchess County.
Nunda Mineral Springs, Nunda, Livingston County.
Oasis Cold Spring, Bergen, Genesee County.
Orenda Spring, Saratoga Springs, Saratoga County.

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Paris Spring, Sanquoit, Oneida County.
Plymouth Spring, North Greenbush, Rensselaer County.
Red Rock Spring, Fine View, Jefferson County.
Risley Cold Spring, near Whitesboro, Oneida County.
Sagamore Spring, Oyster Bay, Nassau County.
Saratoga Gurn Spring, Saratoga Springs, Saratoga County.
Saratoga Soft Sweet Spring, Saratoga Springs, Saratoga County.
Saratoga Vichy and Victoria No. 2 springs, Saratoga Springs, Saratoga County.
Setauket Spring, Setauket, Suffolk County.
Shell Rock Spring, near Rensselaer, Rensselaer County.
Shenorock Spring, Baldwin Place, Westchester County.
Sparkling Spring, Buffalo, Erie County.
Split Rock Lithia Spring, Franklin Springs, Oneida County.
Standard Spring, Troy, Rensselaer County.
Sun Ray Spring, Ellenville, Ulster County.
Table Rock Mineral Spring, Honeoye Falls, Monroe County.
Trespur Spring, McGraw, Cortland County.
Valley Spring, Omar, Jefferson County.
Vita Spring, Fort Edward, Washington County.
Wawbeek Spring, Tupper Lake, Franklin County.
Westmoreland Mineral Spring, Westmoreland, Oneida County.
White Bear Spring, Batavia, Genesee County.
White's Spring, Norwich, Chenango County.

NORTH CAROLINA.

The mineral-water business in North Carolina decreased 16 per cent in quantity and 15 per cent in value during 1915, and the average price remained the same—14 cents. The total sales amounted to 132,813 gallons, valued at $18,745, as compared with 158,226 gallons, valued at $21,964, in 1914. A small quantity of mineral water also was consumed in the manufacture of soft drinks. Twelve resorts, accommodating 1,900 guests, and 2 establishments for bathing in mineral water were maintained at springs. Production was reported for the first time from Bromine Arsenic Lithia Springs. One spring active in 1914 concerning which no report was received in 1915 was considered idle.

The 17 springs that reported production are as follows:

All Healing Spring, Taylorsville, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Bromine Arsenic Lithia Springs, Crumpler, Ashe County.
Buckhorn Lithia Spring, Bullock, Granville County.
Connelly Springs, Connelly Springs, Burke County.
Derita Mineral Spring, Derita, Mecklenburg County.
Haywood White Sulphur Spring, Waynesville, Haywood County.
Huckleberry Spring, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.
Midas Spring, near Huntersville, Mecklenburg County.
Moores Springs, Moores Springs, Stokes County.
Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Spring, Warren County, near Littleton.
Parks Springs, Caswell County, near Danville, Va.
Seven Springs, Sevensprings, Wayne County.
Shelby Lithia Springs, Shelby, Cleveland County.
Vade Mecum Spring, Vade Mecum, Stokes County.

NORTH DAKOTA.

Three springs in North Dakota reported sales of 475,000 gallons of mineral water, valued at $8,750. The total sales in 1914 were 408,000 gallons, valued at $8,150. This change corresponds to an increase of 16 per cent in quantity and 7 per cent in value. One spring active

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in 1914 was unreported in 1915 and has been considered idle. The consumption of mineral water in the manufacture of soft drinks increased from 190,000 gallons in 1914 to 250,000 gallons in 1915. The soft-drink trade in this State has shown a steady increase for several years.

The names and locations of the 3 springs reporting production are as follows:

Granite Spring, Minot, Ward County.
Kenmare Spring, Kenmare, Ward County.
Williston Medicinal Spring, Williston, Williams County.

OHIO.

The quantity of mineral water sold in Ohio during 1915 was practically the same as that during 1914, but the output of moderate-priced medicinal waters dropped from a value of $19,232 in 1914 to $10,923 in 1915. The sales of low-priced table waters did not change; consequently the total value of the production in 1915 was 8 per cent less than that in 1914. Much less mineral water was used in the manufacture of soft drinks. The average price per gallon has been 4 cents for the last six years.

Mineral waters sold in Ohio, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	28	1,958,547	$86,478	4
1912	30	2,709,745	117,287	4
1913	33	3,317,639	125,084	4
1914	35	3,558,413	145,596	4
1915	36	3,504,343	133,416	4

Three new springs, Elm Meade, La France, and Magnetic, were added to the list of producers, and 2 springs temporarily idle in 1914 were producers in 1915. Two springs active in 1914 were reported idle in 1915, and no report could be obtained regarding 1 active in 1914, which has, therefore, been considered idle. One spring idle in 1914 was unreported and considered idle, and the output of 1 spring for which no report could be obtained was estimated in 1915. One spring for which a separate report has heretofore been submitted was reported with another spring in 1915. Thus the total number of active springs in 1915 was 36. Three resorts accommodating 400 guests and 2 mineral-water bathing establishments were maintained.

The 35 springs reporting sales are as follows:

Alba Spring, Rockport, Cuyahoga County.
Beech Rock Spring, near Zanesville, Muskingum County.
Bellmore Springs, near Signal, Columbiana County.
Belmont Spring, Bridgeport, Belmont County.
Chalybeate Spring, Newark, Licking County.
Collingwood Springs, Toledo, Lucas County.
Crum Mineral Spring, Austintown, Mahoning County.
Crystal Spring, Newark, Licking County.
Crystal Fountain Springs, Plainville, Hamilton County.
Devonian Mineral Spring, Lorain, Lorain County.
Elm Meade Spring, Youngstown, Trumbull County.

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Fargo Mineral Springs, Ashtabula, Ashtabula County.
Fisher's Magnesia Spring, Clintonville, Franklin County.
Glenwood Mineral Spring, near Chillicothe, Ross County.
Highland Springs, Akron, Summit County.
La France Spring, Toledo, Lucas County.
Magnetic Spring, Magnetic Springs, Union County.
Maple Grove Mineral Spring, near Chillicothe, Ross County.
Minnehaha Spring, Rockport, Cuyahoga County.
Oak Place Spring, Akron, Summit County.
Oak Ridge Mineral Springs, Sandusky County, near Greenspring.
Partagas Well, Cincinnati, Hamilton County.
Peerless and Puritas springs, West Park, Cuyahoga County.
Pine Tree Spring, Willoughby, Lake County.
Puritas Spring, West Park, Cuyahoga County.
Purity Spring, South Euclid, Cuyahoga County.
Purtlebaugh Spring, Urbana, Champaign County.
Quakerdale Spring, Colerain, Belmont County.
Ripley Bromo Lithia Spring, Ripley, Brown County.
Rock Spring, Wickliffe, Lake County.
Sand Rock Mineral Spring, Canton, Stark County.
Spring Grove Lithia Spring, Springfield, Clark County.
Sulphur Lick Spring, Chillicothe, Ross County.
Tallewanda Springs, Preble County, near College Corner.
Wheeler Mineral Spring, Youngstown, Mahoning County.

OKLAHOMA.

The output of mineral water in Oklahoma during 1915 was 890,392 gallons, valued at $24,005, as compared with 804,675 gallons, valued at $26,906, during 1914. These figures correspond to an increase of 11 per cent in quantity and a decrease of 11 per cent in value. In addition to the quantity sold 19,000 gallons of mineral water was consumed in the manufacture of soft drinks. Bromide Spring and Sparkling Water Well were added to the list of producers. One spring active in 1914 was reported idle in 1915, 1 active in 1914 was unreported in 1915 and was considered idle, and 1 idle in 1914 was active in 1915; thus the total number of springs active in 1915 was 13. Three resorts accommodating 600 guests and 3 mineral-water bathing establishments were maintained.

The 13 springs reporting sales are as follows:

Bromide Spring, Coal County, near Bromide.
Bromide Spring, Sulphur, Murray County.
Everpure Well, Oklahoma City, Oklahoma County.
Excelsior Well, Oklahoma City, Oklahoma County.
Guthrie Mineral Springs, Guthrie, Logan County.
Kalium Wells, Faxon, Comanche County.
Lewis Lithia Wells, Oklahoma City, Oklahoma County.
Living Spring, Oklahoma City, Oklahoma County.
Shanoan Spring, Chickasha, Grady County.
Sparkling Water Well, near Shawnee, Pottawatomie County.
Standard Wells, Tulsa, Tulsa County.
Sulphur Spring, Sapulpa, Creek County.
Works Excelsior Mineral Wells, Comanche, Stephens County.

OREGON.

The mineral-water business in Oregon decreased 50 per cent in quantity and 32 per cent in value during 1915 chiefly because of general decrease in sales. The production was 28,747 gallons, valued at $8,729, as compared with 57,800 gallons, valued at $12,810, during 1914. The average price per gallon rose from 22 to 30 cents. One

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spring idle in 1914 was active in 1915 and 1 spring active in 1914 was unreported and was considered idle in 1915. Thus the number of active springs remained the same. Four resorts accommodating about 1,300 guests and 4 mineral-water bathing establishments were maintained. In addition to the water reported sold about 15,000 gallons was used in manufacturing soft drinks.

The names of the 7 springs reporting production are as follows:

Calapooya Spring, London, Lane County.
Cascade Mineral Spring, Cascadia, Linn County.
Colestin Spring, Colestin, Jackson County.
Klamath Spring, Klamath Falls, Klamath County.
Sam-O Springs, Baker, Baker County.
Selah Spring, Silverton, Marion County.
Wilhbit Spring, Wilhoit, Clackamas County.

PENNSYLVANIA.

The returns from Pennsylvania indicate a decrease of 13 per cent in quantity and 18 per cent in value of mineral water sold during 1915, as compared with reports for 1914, and the price per gallon dropped from 9 to 8 cents chiefly because of decreased sales of rather high-priced table waters. In addition 261,407 gallons was used in manufacturing soft drinks.

Mineral waters sold in Pennsylvania, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	41	2,327,732	$216,819	9
1912	41	2,192,106	204,906	9
1913	43	2,163,931	190,459	9
1914	47	2,457,626	213,752	9
1915	47	2,136,218	174,798	8

Production was reported for the first time from Hi-Rox and No. 1 Mineral springs. West Nanticoke Artesian Springs have formerly been called Blue Mountain Spring, and Great Oak Spring has formerly been called Fern Rock Spring. Three springs temporarily idle in 1914 were producers in 1915. Four springs active in 1914 were reported idle in 1915. Two springs active in 1914 but unreported in 1915 have been considered idle, and three others unreported for two years have also been considered idle. The production of 1 unreported spring has been estimated. Thus the number of active springs remains the same as during 1914. Ten resorts accommodating 1,300 guests and 3 mineral-water bathing establishments were maintained.

The following 46 springs reported sales in 1914:

Battering Ram Spring, Beach Haven, Luzerne County.
Bedford Magnesia Spring, near Bedford, Bedford County.
Brookside Spring, Wilkinsburg, Allegheny County.
Carnegie Alkaline and Lithia Mineral springs, Carnegie, Allegheny County.
Ceres Spring, McKean County, near Ceres.
Chadwick Mineral Spring, Cambridge Springs, Crawford County.
Cloverdale Spring, near Newville, Cumberland County.
Cold Spring, Lotell, Lebanon County.
Colonial Spring, Valley Forge, Chester County.
Dark Hollow Spring, Oakmont, Allegheny County.

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De Profundus Spring, Saegerstown, Crawford County.
De Vita Mineral Spring, Cambridge Springs, Crawford County.
Elkoro Spring, Girard, Erie County.
Ephrata Mountain Crystal Spring, near Ephrata, Lancaster County.
Franklin Lithia Spring, Cambridge Springs, Crawford County.
Glen Crystal Spring, Harbor Creek, Erie County.
Glen Summit Spring, Glen Summit, Luzerne County.
Gray Mineral Spring, Cambridge Springs, Crawford County.
Great Oak Spring, Pottstown, Chester County.
Harrison Valley Mineral Spring, Harrison Valley, Potter County.
Hi-Rox Springs, near Lanesboro, Susquehanna County.
Hurlburt Spring, Cambridge Springs, Crawford County.
Hutchinson's Spring, East Brook, Lawrence County.
Jeny-See Spring, Genesee, Potter County.
Kecksburg Artesian Mineral Spring, Kecksburg, Westmoreland County.
Keystone Spring, near Taylorsville, Bucks County.
Magnetic Mineral Spring, Sizerville, Cameron County.
Minnequa Spring, Canton, Bradford County.
Mount Laurel Spring, Temple, Berks County.
No. 1 Mineral Spring, Mount Jewett, McKean County.
Original Magnesia Springs, Cambridge Springs, Crawford County.
Pavilion Spring, Wernersville, Berks County.
Petticord Spring, Cambridge Springs, Crawford County.
Plymouth Crystal Spring, Plymouth, Luzerne County.
Polar Springs, Morrisville, Bucks County.
Prospect Rock Spring, Laurel Run, Luzerne County.
Puritas Spring, near Erie, Erie County.
Quaill Farm Spring, Bellevue, Allegheny County.
Ross Common Spring, Ross Common, Monroe County.
Springfield Spring, Springfield Township, Delaware County.
Summer Hill Spring, Pittsburgh, Allegheny County.
Thurston Carbonate Spring, Meadville, Crawford County.
Tuckahoe Mineral Springs, near Northumberland, Northumberland County.
West Nanticoke Artesian Springs, West Nanticoke, Luzerne County.
Whann Lithia Spring, Franklin, Venango County.
White House Lithia Spring, Reading, Berks County.

RHODE ISLAND.

Rhode Island reported in 1915 sales from 6 springs amounting to 385,624 gallons, valued at $24,574, or at 6 cents a gallon. The water was sold exclusively for table use, and in addition about 11,000 gallons was used in the manufacture of soft drinks. The sales in 1914 amounted to 438,702 gallons, valued at $29,639, or at 7 cents a gallon. Thus there was a decrease of 12 per cent in quantity and 17 per cent in value. One mineral-water resort was maintained.

The names of the 6 commercial springs are as follows:

Berry Spring, Pawtucket, Providence County.
Girard Spring, North Providence, Providence County.
Gladstone Spring, Narragansett Pier, Washington County.
Holley Mineral Spring, East Woonsocket, Providence County.
Ochee Spring, Providence, Providence County.
Prophet Spring, Providence, Providence County.

SOUTH CAROLINA.

The mineral-water trade in South Carolina during 1915 amounted to 480,051 gallons, valued at $67,869, as compared with 293,949 gallons, valued at $48,071, during 1914. These changes are equivalent to increases of 63 per cent in quantity and 41 per cent in value, and they are caused by increased sales of several waters. Nine-tenths of the output is said to be sold for medicinal use. One spring idle in 1914 was active in 1915, 2 springs active in 1914 were idle in 1915,

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and the output of 1 spring unreported in 1915 was entered as zero. Thus the number of active springs has been reduced to 11. Two resorts accommodating 500 guests were maintained. In addition to the mineral water reported sold 220,651 gallons was used in manufacturing soft drinks.

The following 11 springs reported sales:

Antley's Spring, St. Matthews, Calhoun County.
Buffalo Lick Springs, Carlisle, Union County.
Chick Springs, Chick Springs, Greenville County.
Clementia Mineral Spring, Clementia, Colleton County.
Crystal Carbon Spring, Spartanburg, Spartanburg County.
Glendale Mineral Springs, Bamberg, Bamberg County.
Glenn Springs, Glenn Springs, Spartanburg County.
Harris Lithia Wells, Harris Springs, Laurens County.
Mosely Spring, Loris, Horry County.
Shivar Spring, Shelton, Fairfield County.
Steele Mineral Spring, Rockhill, York County.

SOUTH DAKOTA.

The same 3 springs in South Dakota that reported production of 145,647 gallons of mineral water, valued at $8,999, during 1914, reported production of 176,000 gallons, valued at $9,360, during 1915. All this water was sold for table use, and some in addition was used in manufacturing soft drinks. These figures correspond to increases of 21 per cent in quantity and 4 per cent in value. No resorts or bathing establishments were maintained.

The names of the 3 springs reporting are as follows:

Culbert Spring, Aberdeen, Brown County.
Kampeskee Spring, Watertown, Codington County.
Minnehaha Springs, Sioux Falls, Minnehaha County.

TENNESSEE.

The mineral-water trade of Tennessee showed a decrease of 25 per cent in quantity and 31 per cent in value. The chief decrease was in sales of certain waters marketed for medicinal use. The average price per gallon has remained the same for the last three years.

Mineral waters sold in Tennessee, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	19	1,073,115	$72,475	7
1912	21	796,568	53,560	7
1913	23	1,088,034	64,905	6
1914	23	943,502	56,741	6
1915	23	703,566	39,304	6

Fernwood White Sulphur Spring was added to the list of producers. Two springs idle in 1914 were active in 1915, 2 springs active in 1914 were reported idle in 1915, 2 unreported springs have been considered idle in 1915, and the production of another has been estimated. Fourteen resorts accommodating about 1,900 guests and 2 mineral-water bathing establishments were operated.

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The following 22 springs reported sales:

Bright Sunrise Spring, near Ashland City, Cheatham County.
Bush Epsom Lithia Springs, Davidson County, near Nolensville.
Darnell Well, Clarksville, Montgomery County.
Eagle Bluff Springs, Jacksboro, Campbell County.
Eastbrook Spring, Eastbrook, Franklin County.
Faulkner Springs, near McMinnville, Warren County.
Fernwood White Sulphur Spring, near Morristown, Hamblen County.
Galbraith Epsom Lithia Springs, Mooresburg, Hawkins County.
Hamilton Spring, near Lebanon, Wilson County.
Horn Springs, Horn Springs, Wilson County.
Larkin Spring, Madison, Davidson County.
Montvale Spring, Maryville, Blount County.
Neubert Spring, Neubert, Knox County.
Paris Wells, Paris, Henry County.
Pioneer Lithia Spring, near Nashville, Davidson County.
Red Boiling Springs, Red Boiling Springs, Macon County.
Rhea Springs, Rhea Springs, Rhea County.
Richardsons Lockeland Spring, near Nashville, Davidson County.
Tate Spring, Tate Springs, Grainger County.
Thompson Spring, near Nashville, Davidson County.
Willow Brook Spring, Craggie Hope, Cheatham County.
Wright's Epsom-Lithia Spring, Mooresburg, Hawkins County.

TEXAS.

There was an increase in the mineral-water business in Texas during 1915 of 9 per cent in quantity and 8 per cent in value, most of the water, as during 1914, having been reported as sold for medicinal use. In addition some mineral water was consumed in manufacturing soft drinks.

Mineral waters sold in Texas, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	40	1,637,932	$158,367	10
1912	34	1,292,992	151,395	12
1913	38	1,187,612	132,488	11
1914	31	766,597	93,014	12
1915	29	835,142	100,090	12

No new springs were reported. Four springs active in 1914 were reported idle in 1915, 3 idle in 1914 were active in 1915, and 1 active in 1914 was unreported and considered idle in 1915. Six other springs idle or unreported in 1914 were considered idle in 1915. Nine resorts accommodating about 2,500 guests and 2 mineral-water bathing establishments were reported.

The following is the list of the 29 springs reporting sales during 1915:

Aqua Vitae Wells, Nacogdoches, Nacogdoches County.
Austin Well, Mineral Wells, Palo Pinto County.
Beauchamp's Well, Blossom, Lamar County.
Brock Mineral Well, near Denton, Denton County.
Capp's Wells, Longview, Gregg County.
Carlsbad Well, Blossom, Lamar County.
Crazy and Gibson wells, Mineral Wells, Palo Pinto County.
Georgetown Mineral Wells, Georgetown, Williamson County.
Hefner Well, Blossom, Lamar County.

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Hubbard Hot Well, Hubbard, Hill County.
Lamar Wells, Mineral Wells, Palo Pinto County.
Lonestar Mineral Well, Texarkana, Bowie County.
Mangum Wells, Mangum, Eastland County.
Marlin Hot Wells, Marlin, Falls County.
Maurice Wells, Mangum, Eastland County.
Olympia Well, Mineral Wells, Palo Pinto County.
Overall Mineral Wells, Franklin, Robertson County.
Riviere Wells, Tyler, Smith County.
Roach Well, near Mount Pleasant, Titus County.
Rock Bottom Well, Mineral Wells, Palo Pinto County.
Rosborough Spring, Marshall, Harrison County.
St. Mary's Mineral Well, near Hallettsville, Lavaca County.
Sour Wells, Sulphur Springs, Hopkins County.
Southland Spring, Duffau, Erath County.
Star Well, Mineral Wells, Palo Pinto County.
Texas Carlsbad Spring, Mineral Wells, Palo Pinto County.
Tioga Mineral Wells, Tioga, Grayson County.
Weatherby Wells, Garrison, Nacogdoches County.
Wizard Wells, Wizard Wells, Jack County.

UTAH.

Two springs in Utah reported production in 1915, and statistics regarding them are included with those of other States having less than three operating springs.

The names and locations of the springs reporting are:

Deseret Lithia Spring, Deseret, Millard County.
Utalina Springs, Wasatch Mountains.

VERMONT.

The mineral-water trade in Vermont during 1915 was 20 per cent greater in quantity and 67 per cent greater in value than during 1914. The production was 61,540 gallons, valued at $14,382, as compared with 51,151 gallons, valued at $8,600, during 1914. The average price per gallon increased from 17 to 23 cents. In addition to this production about 30,000 gallons was used in making soft drinks. Four resorts accommodating nearly 700 guests and 2 mineral-water bathing establishments were maintained. Production was reported for the first time from North Spring, and the report on Cold Spring, formerly known as Vermont Mineral Spring, has been transferred to Vermont from New York.

Five springs were active, as follows:

Alburg Springs, Alburg Springs, Grand Isle County.
Brunswick Springs, Brunswick, Essex County.
Clarendon and North springs, Clarendon, Rutland, County.
Cold Spring, Wells, Rutland County.
Equinox Spring, Manchester, Bennington County.

VIRGINIA.

The State of Virginia tied California for second rank in number of commercial springs in 1915 and ranked fourth in consumption of mineral water for manufacture of soft drinks, sixth in production, and fifth in total value. Sales increased 4 per cent in quantity over those during 1914, but decreased 19 per cent in value chiefly because of decreased marketing of several well-known table waters. In addition, 350,753 gallons was used in manufacturing soft drinks.

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Mineral waters sold in Virginia, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	43	2,474,918	$298,701	12
1912	45	2,762,319	349,255	13
1913	49	2,873,288	298,473	10
1914	50	2,906,976	293,512	10
1915	50	3,027,528	237,818	8

Production was reported from Crystal Springs for the first time. Two springs idle in 1914 were active in 1915, and 3 active in 1914 were reported idle in 1915. Thus the number of active springs remained the same. Twelve resorts accommodating nearly 1,800 guests and 5 mineral-water bathing establishments were maintained at springs.

The 50 springs reporting sales are as follows:

Albevanna Ponce de Leon Spring, Fluvanna County, near Scottsville.
Alkaline Lithia Spring, near Staunton, Augusta County.
Alleghany Spring, Alleghany Spring, Montgomery County.
Bear Lithia Spring, near Elkton, Rockingham County.
Beaufont Spring, Chesterfield County, near Richmond.
Berry Hill Mineral Spring, Elkwood, Culpepper County.
Blue Ridge Springs, near Blue Ridge Springs, Botetourt County.
Broad Rock Mineral Spring, Chesterfield County, near Richmond.
Brugh Spring, Nace, Botetourt County.
Buckhead Spring, Buckhead Springs, Chesterfield County.
Buffalo Lithia Springs, Buffalo Lithia Springs, Mecklenburg County.
Burnett Mineral Spring, Culpeper, Culpeper County.
Campfield Lithia Springs, Chesterfield County, near Richmond.
Carter Springs, Danville, Pittsylvania County.
Chlorinated Calcic Spring, Norfolk, Norfolk County.
Como Lithia Spring, East Richmond, Henrico County.
Coppahaunk Mineral Springs, Waverly, Sussex County.
Crockett Arsenic Lithia Spring, Crockett Springs, Montgomery County.
Crystal Springs, near Newport News.
Diamond Spring, Princess Anne County, near Norfolk.
Eaglewood Springs, near Danville, Pittsylvania County.
Erup Mineral Spring, near Glencarlyn, Alexandria County.
Farmville Lithia Springs, Cumberland County, near Farmville.
Fonticello Mineral Spring, Chesterfield County, near Richmond.
Granite Mineral Springs, Chesterfield County, near Richmond.
Harris Anti-Dyspeptic Spring, Burkeville, Nottoway County.
Healing Springs, Healing Springs, Bath County.
Jeffress Lithia Spring, Jeffress, Mecklenburg County.
Kayser Lithia Springs, Staunton, Augusta County.
Landale Spring, Norfolk, Norfolk County.
Lithia Magnesia Spring, Rockymount, Franklin County.
Magee Chlorinated Lithia Springs, Clarksville, Mecklenburg County.
Massanetta Spring, near Harrisonburg, Rockingham County.
Mecklenburg Medicinal Springs, Chase City, Mecklenburg County.
Mico Well, Alexandria, Alexandria County.
Mulberry Island Well, Mulberry Island, Warwick County.
Nye Lithia Springs, Wytheville, Wythe County.
Otterburn Lithia Spring, Amelia C. H., Amelia County.
Paeonian Spring, Paeonian Springs, Loudoun County.
Pickett Spring, Worsham, Prince Edward County.
Rockbridge Alum Springs, Rockbridge Alum Springs, Rockbridge County.
Rubino Healing Springs, Healing Springs, Bath County.
Seawright Magnesian Lithia Spring, near Staunton, Augusta County.
Stribling Springs, Mount Solon, Augusta County.
Trepho Mineral Spring, Claremont, Surry County.

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Virginia Etna Springs, Vinton, Roanoke County.
Virginia Lithia Spring, Chesterfield, Chesterfield County.
Virginia Springs, near Staunton, Augusta County.
Wallawhatoola Springs, Millboro, Bath County.
Wyrick Mineral Spring, Crockett, Wythe County.

WASHINGTON.

Washington's output of mineral water during 1915 was 158,865 gallons, valued at $11,703, or at 7 cents a gallon, whereas the output during 1914 was 180,787 gallons, valued at $28,777, or at 16 cents a gallon. Thus there was a decrease of 12 per cent in quantity and 59 per cent in value. This change was caused chiefly by reduced sales of certain high-priced waters. No new springs were reported. One spring active in 1914 was idle in 1915. One resort and 1 mineral-water bathing establishment were maintained and some mineral water also was used in manufacturing soft drinks.

The names of the 5 active springs are:

Ahtanum Soda Springs, near Tampico, Yakima County.
Diamond Mineral Spring, Auburn, King County.
Klickitat Mineral Springs, Klickitat, Klickitat County.
Olympia Hygeian Spring, Tumwater, Thurston County.
Yakima Artesian Mineral Spring, North Yakima, Yakima County.

WEST VIRGINIA.

The total sales of mineral water in West Virginia during 1915 amounted to 314,909 gallons, valued at $50,271, as compared with 307,890 gallons, valued at $49,129, during 1914. This change is equivalent to an increase of 2 per cent in quantity and value. One spring active in 1914 was idle in 1915 and 1 spring active in 1914 was unreported and was considered idle in 1915. Production was reported for the first time from Webster Springs Salt Lithia Springs. Five resorts, accommodating 2,500 guests, and 2 mineral-water bathing establishments were operated at springs.

The following are the names of the 9 commercial springs reporting in 1915:

Borland Springs, Borland, Pleasants County.
Madeira Well, Morgantown, Monongalia County.
Manacea Irondale Spring, Independence, Preston County.
Pence Spring, Pence Springs, Summers County.
Saline Chalybeate and Vigora springs, Woodsdale, Ohio County.
Walnut Hill Lithia Spring, near Charleston, Kanawha County.
Webster Springs Salt Sulphur Spring and Webster Springs Salt Lithia Springs, Webster Springs, Webster County.

WISCONSIN.

The State of Wisconsin ranked first in total value of production of mineral waters and in value of table waters in 1915, sixth in value of medicinal waters, eighth in number of commercial springs, and second in consumption of mineral water for manufacture of soft drinks. This record reflects chiefly the great activity of several large producers of moderate-priced table waters. Though the quantity bottled and sold was 6 per cent less than that bottled and sold in 1914 its value was 79 per cent greater because of a general rise in the price of several waters. The average price per gallon was double that in 1914. About 800,000 gallons of mineral water also was used in the manufacture of soft drinks.

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Mineral waters sold in Wisconsin, 1911–1915.

Year.	Commercial springs.	Quantity sold.	Value.	Average price per gallon.
		Gallons.		*Cents.*
1911	31	5,716,162	$955,988	17
1912	31	6,045,719	869,495	14
1913	34	6,326,533	872,518	14
1914	35	5,145,452	588,373	11
1915	36	4,861,734	1,051,405	22

Two resorts accommodating about 1,500 guests and 1 mineral-water bathing establishment were operated at springs. One spring temporarily idle in 1914 was productive in 1915. Four springs not reported for two or more years have been considered idle in 1915; thus the total number of springs reporting production was 36, as follows:

Allouez Mineral Spring, Green Bay, Brown County.
Andersons Waukesha Spring, Waukesha, Waukesha County.
Arbutus Mineral Spring, Oconto, Oconto County.
Arcadian Spring, Waukesha, Waukesha County.
Bay City Spring, Ashland, Ashland County.
Bethania Spring, Osceola, Polk County.
Bethesda Spring, Waukesha, Waukesha County.
Castalia Spring, Wauwatosa, Milwaukee County.
Chippewa Spring, Chippewa Falls, Chippewa County.
Clysmic Spring, Waukesha, Waukesha County.
Crystal Spring, Sheboygan, Sheboygan County.
Crystal Springs, Waupaca, Waupaca County.
Darlington Mineral Springs, Darlington, Lafayette County.
Deep Rock Spring, Palmyra, Jefferson County.
Elysian Spring, Prairie du Chien, Crawford County.
Famous Springs, Menominee Falls, Waukesha County.
Fontana Lithia Spring, Fontana, Walworth County.
Glenn Rock Spring, Waukesha, Waukesha County.
Horeb Spring, Waukesha, Waukesha County.
Kusche Spring, Oshkosh, Winnebago County.
Lebenswasser Spring, Green Bay, Brown County.
Maribel Mineral Spring, Maribel, Manitowoc County.
Nee-Ska-Ra Spring, Wauwatosa, Milwaukee County.
Rainbow Mineral Spring, Wautoma, Waushara County.
Salvator Mineral Spring, Green Bay, Brown County.
Sheboygan Spring, Sheboygan, Sheboygan County.
Sheridan Mineral Springs, near Lake Geneva, Walworth County.
Silurian Spring, Waukesha, Waukesha County.
Silver Spring, Madison, Dane County.
Soda-Lithia Spring, Fussville, near Menominee Falls, Waukesha County.
Sulphur Mineral Springs, Oshkosh, Winnebago County.
Waukesha AAAA Spring, Waukesha, Waukesha County.
Waukesha Fox Head Spring, Waukesha, Waukesha County.
Waukesha Roxo Spring, Waukesha, Waukesha County.
White Rock Spring, Waukesha, Waukesha County.
Wilnette Spring, Cooper Station, Racine County.

WYOMING.

Sales from 5 springs in Wyoming during 1915 amounted to 68,584 gallons, valued at $9,059, or nearly the same production and value as during 1914. One spring not reporting for two years has been considered idle, and 1 spring from which report of production could not be obtained in 1914 was reported active in 1915.

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City Spring was added to the list of producers. One small resort and 2 mineral-water bathing establishments were operated, and about 40,000 gallons of mineral water also was used in the manufacture of soft drinks.

The names of the 5 reporting springs are as follows:

Big Horn Hot Springs, Thermopolis, Hot Springs County.
City Spring, near Laramie, Albany County.
De Maris Spring, Cody, Park County.
Paulson Well, Saratoga, Carbon County.
Rocky Mountain Spring, Granite Canon, Laramie County.

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COAL—PART A, PRODUCTION.

By C. E. LESHER.

INTRODUCTION.

GENERAL STATEMENT.

The wide interest in statistics of coal among operators, railroad officials, financiers, and the representatives of labor, and the increasing demand from these and other sources for more elaborate figures have led the United States Geological Survey to attempt several additions for 1915 to the regular annual report on coal. The most important addition is the presentation of data covering the various uses to which the coal from each State was put and the States or localities to which it was shipped for consumption.

Those familiar with the methods of marketing coal will at once appreciate the difficulty attending the acquisition and compilation of reports showing these data, for not only is it difficult for the operator or shipper to ascertain the statistics from his records, but the liability of duplication of figures has to be met, as in many instances the same coal was rehandled one or more times between mine and consumer.

The sources of information and the methods of compilation are discussed in detail in connection with the statistics of distribution given in Part B of this report.

Previous chapters of this series have included brief descriptions of the coal fields of the United States, and the report for 1910 (the supply of which is now exhausted) contains maps of the coal-bearing areas in each State. This feature has been omitted from the present chapter, as a comprehensive report on the coal fields of the United States is now in preparation, to be issued as Professional Paper 100. The introduction (U. S. Geol. Survey Prof. Paper 100–A, by M. R. Campbell), now in press, contains summarized descriptions of the various coal fields, estimates of reserves, representative analyses, and several maps, one on large scale showing the coal fields of the United States, each kind of coal being represented in different color.

The Mineral Resources chapter on coal in 1915 has been divided into two parts, Part A giving the usual statistics of production and Part B covering distribution and use, exports and imports, and reviews of the coal trade in the principal cities. As the statistics of production have been completed in advance of the other material, Part A is issued now in order that these statistics may be available at the earliest possible date; Part B will follow, and the two parts will form the complete chapter on coal in 1915.

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ACKNOWLEDGMENTS.

The writer wishes to express his very hearty appreciation of the good will and cooperation of the corporations, firms, and individuals engaged in the coal industry, whose voluntary reports of operations have made possible the complete statistics presented. The cooperation of the officials of 104 railroads in furnishing monthly statements of movements of coal and coke and other data, and the assistance rendered by the chief mine inspectors of Alabama, Pennsylvania, and West Virginia, the chief of the department of mines of Kentucky, and the officials of the Ohio industrial commission, as well as by secretaries of boards of trade and other local authorities, are gratefully acknowledged. The State geologists of Alabama, Illinois, Iowa, Maryland, Oregon, Virginia, and Washington cooperated in the collection of the reports from the coal operators. Particular credit is due to Miss Lida Mann and Mrs. H. L. Bennit, of the United States Geological Survey, for efficient clerical assistance.

UNIT OF MEASUREMENT.

The standard unit of measurement adopted for this report is the net ton of 2,000 pounds, although for certain uses the gross ton is employed. Pennsylvania anthracite is mined and sold by the gross ton of 2,240 pounds, and that unit is used in the part of the report dealing with that product. In all other statistics of production reported to the Survey in gross tons the figures have been reduced to net tons, and unless otherwise expressly stated the net ton is meant where any statement of quantity is made in the text.

REVIEW OF THE COAL INDUSTRY IN 1915.

Summary of statistics of coal produced in 1914 and 1915.

	1914		1915	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.
Bituminous coal and lignite	422,703,970	$493,309,244	442,624,426	$502,037,688
Pennsylvania anthracite	90,821,507	188,181,399	88,995,061	184,653,498
	513,525,477	681,490,643	531,619,487	686,691,186

	Increase or decrease, 1915.			
	Quantity		Value.	
	Net tons.	Per cent.	Dollars.	Per cent.
Bituminous coal and lignite	+19,920,456	+4.7	+8,728,444	+1.8
Pennsylvania anthracite	— 1,826,446	—2.0	—3,527,901	—1.9
	+18,094,010	+3.5	+5,200,543	+ .8

The bituminous coal industry in 1915 responded in a gratifying manner to the quickening in all lines of business, and the record for the year shows an increase in the total quantity produced of nearly

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5 per cent over 1914. The returns to the producers were, however, lower, the average price per ton at the mines declining from $1.17 in 1914 to $1.13 in 1915, with the result that the total value increased less than 2 per cent. Pennsylvania anthracite, production and value, decreased about 2 per cent.

A car shortage, which began to develop in September and October and became acute in November and December, had the effect of halting production and strengthening market prices of coal from certain producing districts. This car shortage was felt the most in the northeastern section of the country, and for a time upset the ordinary course of the coal trade. Numerous embargoes were placed by the railroads, and in some districts there was difficulty in getting fuel. The demand for coal for immediate delivery was in excess of the available supply, and locally prices rose to such an extent that West Virginia operators were able to enter eastern Pennsylvania markets, and Ohio coal was moved by rail across New York to New England consumers. These were exceptional conditions, however, and netted the producer little, as the premium was absorbed by the railroads in the extra freight involved in the long haul.

The monthly rate of production in 1915 is indicated graphically by figure 13. This diagram, which shows shipments of coal and coke by railroads, is based on monthly statements to the Geological Survey from 104 railroads reaching the coal fields in every producing State and originating over 90 per cent of the bituminous coal, lignite, and beehive coke shipped by rail, or about 85 per cent of the total production. The reports from the railroads, which for the most part are received by the Survey within the first 12 days after the end of the month covered, show, except for a few railroads, both revenue (commercial) coal and nonrevenue (company use) coal, and are reported as cars or tons. Only coal and coke originating on these respective lines are reported. The figures thus obtained, although not in themselves final, are comparable from month to month and from year to year, and when considered in connection with the actual quantities loaded on each road, shown by the annual returns from the mine operators, they furnish a very close approximation to the current production and form a reliable basis for prompt estimation of the coal output at any time.

The production in January, 1915, shown in figure 13, was the highest for any month of the first half of the year. February, a short month, had a marked decrease, and March, usually a good month, did not show much improvement. Another low point was reached in April, and from that time on each succeeding month showed increase. The influence of the car shortage is plainly shown by the sudden flattening of the curve for November and December, during which period the previous rate of increase was not maintained.

The surpluses and shortages of freight cars reported on the first day of each month by the committee on relations between railroads of the American Railway Association, are shown graphically in figure 14. In explanation of these figures, it may be said that shortages and surpluses may occur simultaneously on different parts of the same railroad and are to be expected at the same time on different roads throughout the country in all classes of freight equipment. When the surplus is at its maximum any shortage that may be shown is small and extremely local in character. Such a condition represents

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a period of slack railroad business and coincident dullness in the industries. A small surplus of freight equipment is indicative of heavy transportation movement and prosperity and is usually attended by a shortage, the magnitude of which depends, of course, on the ability of

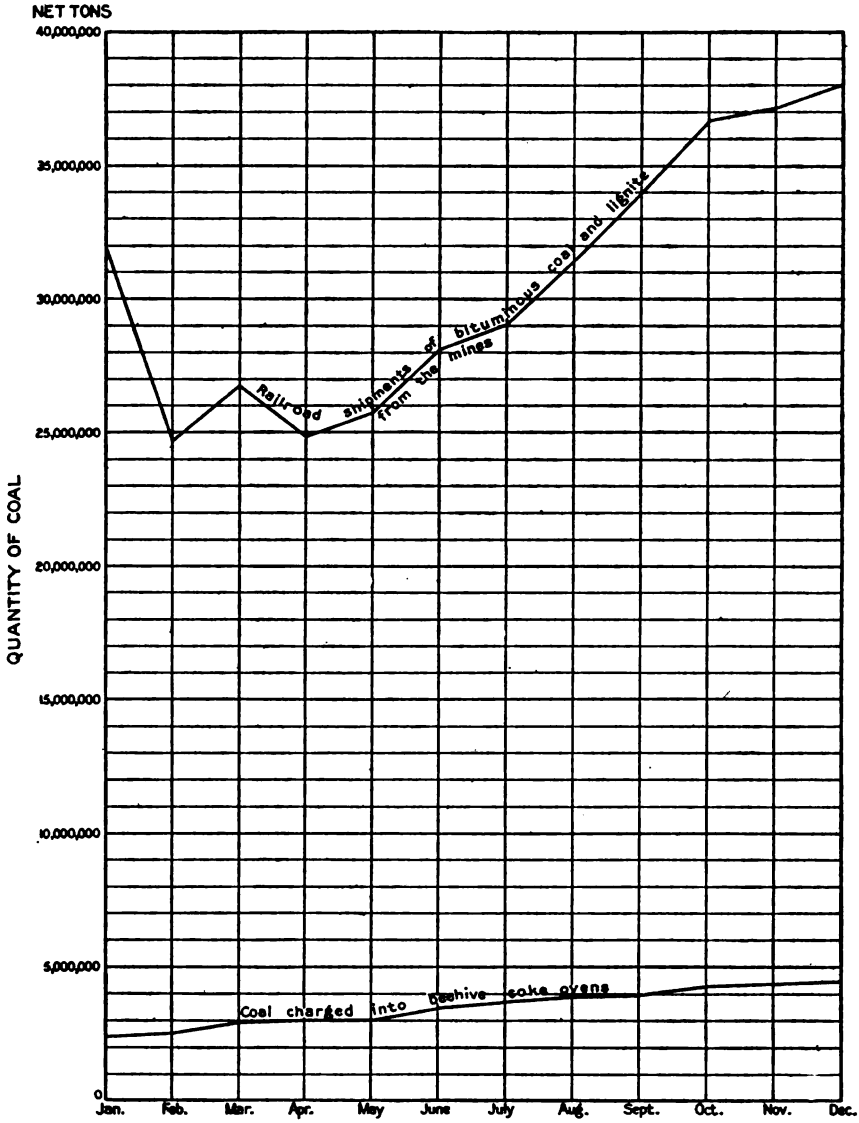

FIGURE 13.—Shipments by railroad of bituminous coal and lignite originating at the mine, and quantity of coal charged into beehive coke ovens in the United States, by months, in 1915.

the railroads to keep the surplus cars moving toward the points of shortage. Any condition that ties up a large number of cars and prevents their prompt unloading and return to service reduces the surplus of cars and tends to aggravate the shortage.

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All these conditions occurred in 1915 and had a distinct effect upon the coal industry. As shown in figure 14, there was an abundance of idle freight cars of all classes during the first half of the year. About the middle of the year a sudden revival in business developed, and then began a great movement of freight to the eastern seaboard. Sufficient vessels to remove the freight were lacking, and when docks and warehouses became full and no more cars could be unloaded the loaded cars were collected in yards and on all available sidetracks. Large numbers of cars were thus tied up and the surplus rapidly disappeared, September and October (fig. 14) showing large diminution. Loaded coal cars were hopelessly mixed up in this congestion,

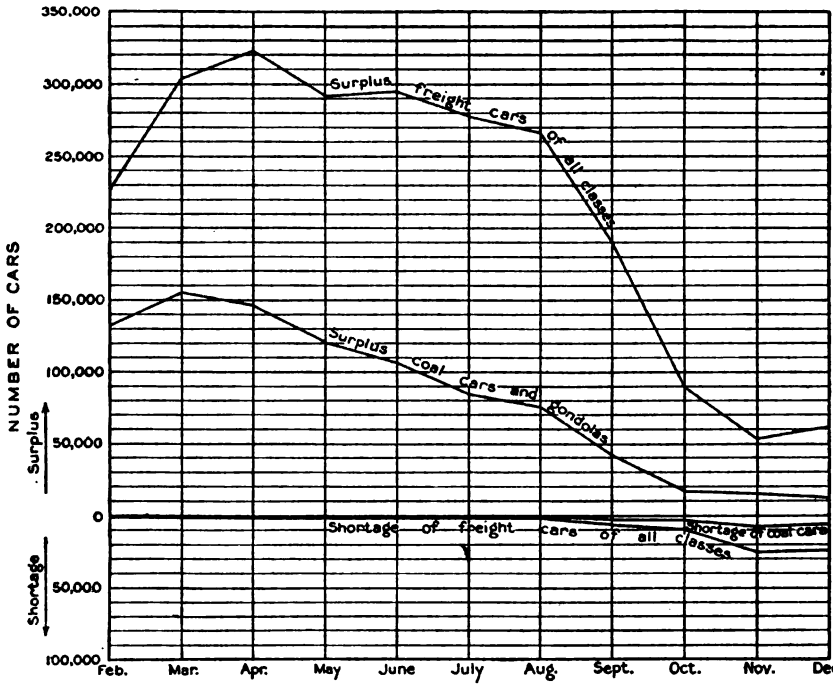

FIGURE 14.—Surpluses and shortages of freight cars of all classes and of coal cars and gondolas, by months, in 1915, reported by the American Railway Association. (Figures for January, 1915, are not available.)

with the result that by October the surplus of coal cars was greatly diminished and in November a decided shortage was apparent. The manner in which the car situation is related to and affects production of coal is brought out in a comparison between figures 13 and 14. The supply of idle coal cars and gondolas showed the first marked decrease in May, in which month the rate of production began to rise. Surplus coal cars decreased in number through the summer and fall as production rose, and in November, when the surplus was low and the shortage reached its maximum for the year, the rate of increase in shipments of coal quickly dropped. The measures that were adopted to relieve the congestion were evidently partly successful; for the surplus of cars increased in January, 1916, the shortage became less acute, and shipments of coal again increased.

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The reserves of bituminous coal in the United States are immense, and the area under development and the necessary mechanical equipment available—the productive capacity, in other words—have kept pace with any demand that has yet developed. In this important respect the coal industry differs from that of the allied but competitive fuels, petroleum and natural gas. With the potential supply of the country as a whole always greater than the demand, the production of coal, a fluctuating quantity, depends on conditions and circumstances outside the coal fields. Two factors, however, labor and car supply, constitute exceptions to this generalization. The effect of surplus and shortage of cars has been described, and with regard to the possibility of inadequate supply of labor, it is to be noted that in 1913, the year of maximum recorded production of coal, the bituminous miners worked an average of only 232 days out of a possible 250 to 300 days. On the other hand, the proved reserves of petroleum and natural gas are more restricted than those of coal, and the available marketable supply is limited by the number of productive wells in existence at any time. Supply and demand alternate as ruling factors; and as new wells are essential to maintain or increase output, a demand in excess of supply is corrected by drilling activity inspired by rising prices. Drilling an oil well and opening a coal mine are both speculative ventures, differing, however, in that in one success depends on finding oil or gas and, in the other, on finding a market for the coal.

Aside from its use as domestic fuel, the production of coal is directly affected by the industrial life of the nation. Mechanical power and heat are fundamental necessaries of industry, and coal is the principal source of heat and power. It is therefore to be expected that any tendency either of progress or of retrogression in business will be reflected in the production of coal. Among other things the amount of bank clearings, the mining of iron ore, the manufacture of pig iron, and the activities of the railroads, as shown by their gross operating revenues, may all be considered to mark the pace at which business is traveling. The relation of these various elements to coal mining is clearly shown in a quantitative way by the curves in figure 15, which show these data for a period of years. The parallelism is more closely illustrated by the curves in figure 16, showing by months for 1915 the gross operating revenues of railroads (curve A) as compiled by the Interstate Commerce Commission, the production of pig iron (curve B) as reported by The Iron Age, and the shipments of coal (curve C) as compiled by the United States Geological Survey.

Not all coal-producing districts shared in the increase in 1915. The decrease in certain States was more than offset, however, by the increase in the others, so that the total for the country was an increase. The coal fields and the record of their progress in 1915 are illustrated in the accompanying map (Pl. III).

The improvement in business to which the increase in production of coal has been attributed did not begin in all regions at the same time nor was its influence everywhere equal. A discussion of the reasons for the increasing prosperity in 1915, which in turn caused more coal to be mined, is outside the province of this report, but it is evident that one of the most potent factors was the demand from the warring nations for foodstuffs, commodities, and manufactures

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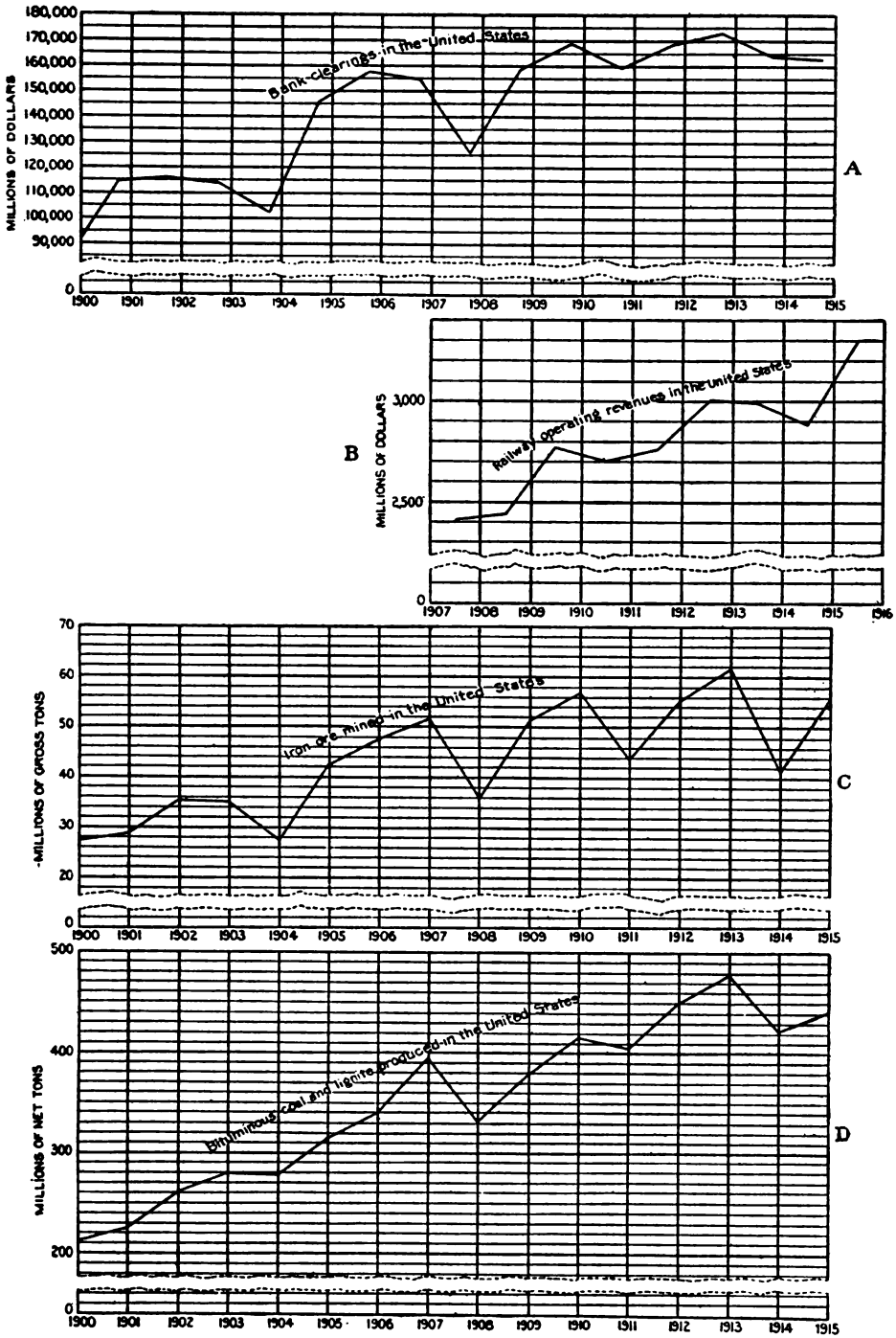

FIGURE 15.—Graphic representation of the progress of the United States, as indicated by the amount of bank clearings, the quantity of iron ore mined, the gross revenues of the railroads, and the bituminous coal produced during the period 1900–1915. The bank clearings are for the years ended September 30 and the railroad revenues for the years ended June 30, and they have been plotted accordingly. The statistics of railroad revenues are available only for the fiscal years 1908–1916. It will be noted that the characteristics of these curves are all alike and that the high and the low points occur in the same years. The years of depression were 1904, 1908, 1911, and 1914, and the years 1902–3, 1907, and 1913 represent the high points of prosperity. It will be noted also that following the low points, there were usually several years each showing successively greater progress until the high points are reached, and that there was but one year of depression; also that the general level of each high and low point is above the preceding one. (The statistics of bank clearings are from compilations by the Department of Commerce; the railroad revenues are supplied by the Interstate Commerce Commission; the production of iron ore and coal are the figures of the United States Geological Survey.)

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of almost every kind, as well as for munitions of war. This demand was soonest felt in the manufacturing districts lying north of the Potomac and east of Chicago, inclusive. Hence the coal fields from which the fuel for this territory is mainly drawn showed the greatest progress. There was another cause for increased output of coal,

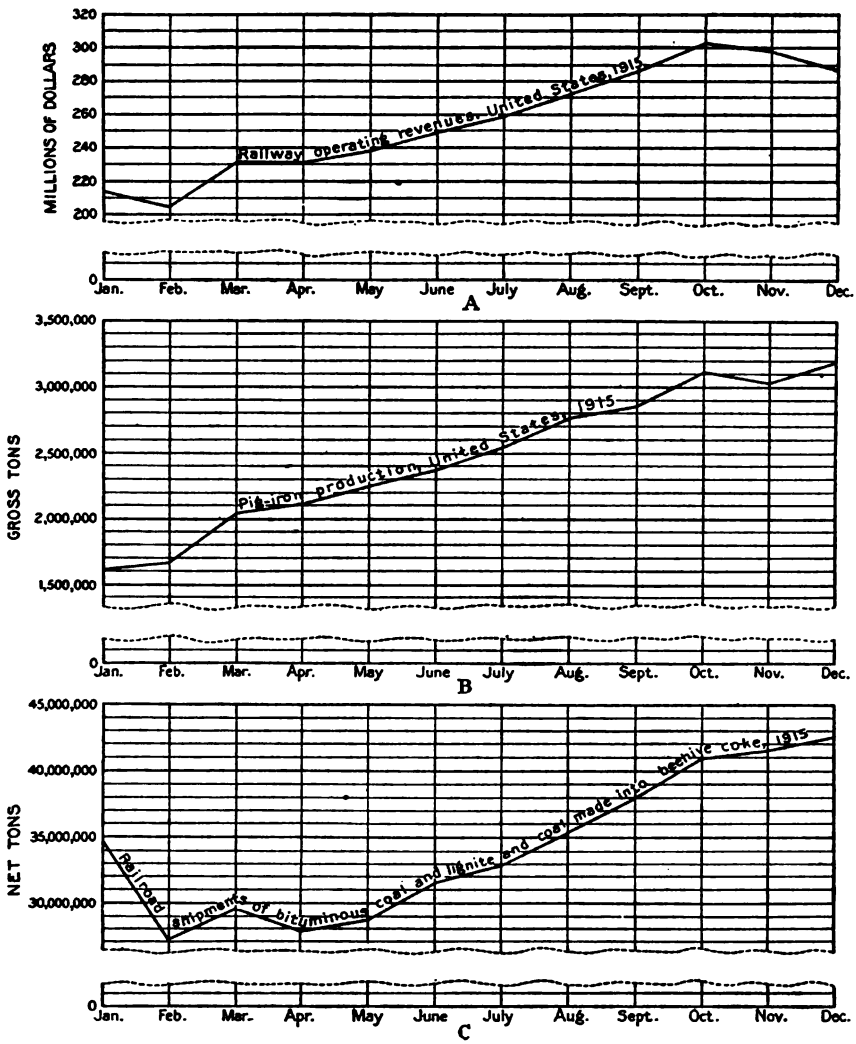

FIGURE 16.—Progress of the United States in 1915, by months, as indicated by railroad revenues and by production of pig iron and bituminous coal. (Pig-iron statistics from The Iron Age, railway-operating revenues from the Interstate Commerce Commission, and shipments of coal compiled by the United States Geological Survey.)

particularly in the area under discussion, the influence of which was felt perhaps as early as August and continued in effect through the first three months of 1916, namely, the storage of coal by those consumers whose supplies come from the unionized coal fields in which the old wage agreements were to expire April 1, 1916. There

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was considerable apprehension with regard to the successful negotiation of new agreements, and the possibility of a shutdown of the mines caused many consumers to adopt a policy of preparedness; as a result the buying of coal was for a period in excess of the needs for immediate consumption. The movement was initiated by the railroads and users of steam coal, particularly manufacturers with large contracts to fill, soon followed their lead. Although only incomplete statistics of storage are available, there is evidence to indicate that between the later part of the summer of 1915 and the end of March, 1916, not less than 10,000,000 tons of bituminous coal were put into stock piles and the quantity may have been nearly 15,000,000 tons.

The Southern Appalachian States and the territory west of the Mississippi and south of Iowa, including Texas, showed decrease, compared with 1914. The revival in the iron business in Alabama was notable, but it arrived too late in the year to overcome the depression of the earlier months. The coal from these regions meets strong competition from fuel oil, not only from domestic sources but also from the Mexican oil fields. The large increase in the output of petroleum in Oklahoma, Texas, and Louisiana in 1914 and 1915 and the substitution of oil for coal as fuel on locomotives and in many steam plants have curtailed the markets for southern and southwestern coal to a noticeable degree. The price of oil is liable to sudden and wide fluctuations, and any increase beyond the prices prevailing at the end of 1915 will result in less oil and more coal being used. Metal mining and smelting in the Western States felt the beneficial effects of war prices, and the coal fields from which the supplies of coal and coke are drawn for these industries showed increases, Colorado, Wyoming, and Utah benefiting more than the other States. The general decrease in production of coal on the Pacific coast is attributed mainly to the increased use of fuel oil from the California fields.

In connection with the statistics for each State (pp. 379–431) the coal trade of the separate districts, including Pennsylvania anthracite, is reviewed in greater detail, and local influences are considered.

With respect to the number of men employed, the year 1915 showed a decrease in both the bituminous and the anthracite regions compared with 1914. When times are prosperous not only is there greater demand for coal but also for labor, with the result that in such times the mines are operated more days and the men have larger earnings. There is evidence (discussed on p. 360) in the labor statistics that there was a decided tendency toward a shortage in labor, for although the average annual output of bituminous coal per employee—which is the index of labor supply—increased from 724 tons in 1914 to 794 in 1915, it was less than the records established in 1912 and 1913. The noteworthy feature, however, is that 1915 is the only year during the last fifteen when there was a notable decrease in the number of employees in conjunction with an increase in production. (See curve D, fig. 17.) There were no serious labor troubles in 1915 compared with 1914, nearly every bituminous region recording decreased number of days lost because of strikes.

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PRODUCTION.

The statistics of the production of coal in the United States in 1914 and 1915, by States, are shown in the accompanying tables. In the first column the quantities loaded at the mines on railroad cars or on boats for shipment are given. Some of the coal reported under this heading, however, is shipped but a short distance and is really used locally. For instance, a considerable portion of the coal mined in the Birmingham, Ala., district is used locally by the iron and steel industry, but as the coal is loaded on railroad cars and the tonnage appears in the statistics of movement of coal, it is placed under the heading of shipped coal. A portion of the coal made into beehive coke in the mining regions is loaded on cars, and, although transported perhaps only a mile or less, is recorded as shipped coal. It should be noted that not all of the coal shipped carries a freight charge or furnishes the railroads revenue, as the coal for the use of the roads entering the coal fields is nonrevenue freight.

In the second column the quantities used locally are given. Under that designation are included wagon trade, coal used by employees, coal loaded directly from the tipple into engine tenders, and that part of the product used in the immediate vicinity of the mine by such industries as brick and sewer-pipe plants, power plants, and mills of various kinds. It is presumably transported from the mine to the place of consumption in the mine cars, by wagons, or on private tramroads. The coal used to generate steam and heat for the operation of the mine is shown in the third column and that charged into coke ovens directly is given in the fourth column. The total quantity, which is the sum of these items, represents only the usable fuel. Refuse, slate, and bone brought out of the mine or picked or sorted from the coal in the tipple and refuse from washeries and dry-cleaning plants are not considered as part of the quantity of coal produced, although the cost per ton of bringing this material to the surface is as great as that of the coal. The total value is the sum of all the values reported by the individual operators, and the average value is the total divided by the total tons.

The schedules sent out by the Geological Survey request that the total number of full days each mine was operated be given, and also the average number of employees, exclusive of office force and coke workers. The number of days a mine was operated is shown directly by the mine records, and the average number of employees is obtained by dividing the number of days into the total shifts, or "men-days," recorded in the pay rolls or time books at each operation. The sum of the number of men thus reported (obtained in the Survey) is considered the total for each county and State, or for the United States, as the case may be. The sum of the men-days for all mines is divided by the total number of employees thus obtained to ascertain the average number of days the total number of men were at work or that the mines were active.

The quantity and value of the coal produced in each State in the five years 1911–1915, with the change and percentage of change in 1915, are shown in the third of the following tables. The annual production of coal in each State from the time of earliest recorded output until the close of 1915 is given in the tabular statement in the pocket.

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Coal produced in the United States in 1914.

State.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Alabama	13,145,854	132,793	626,082	1,688,693	15,593,422	$20,849,919	$1.34	24,042	226
Arkansas	1,735,869	13,605	87,066	.....	1,836,540	3,158,168	1.72	4,339	143
California, Idaho, and Nevada	4,200	9,174	600	.....	13,974	39,821	2.85	43	291
Colorado	6,402,790	314,143	300,145	1,153,476	8,170,559	13,601,718	1.66	10,096	244
Georgia	85,645	1,400	7,900	71,553	166,498	239,462	1.44	355	207
Illinois	53,583,390	2,516,503	1,489,304	.....	57,589,197	64,693,529	1.12	79,490	173
Indiana	15,497,998	689,057	454,077	.....	16,641,132	18,290,928	1.10	23,175	168
Iowa	6,676,392	617,768	156,862	.....	7,451,022	13,364,070	1.79	16,057	204
Kansas	6,553,243	148,928	158,817	.....	6,860,988	11,238,253	1.64	12,448	192
Kentucky	18,896,135	637,919	452,129	396,580	20,382,763	20,852,463	1.02	28,764	187
Maryland	4,019,622	49,569	64,356	.....	4,133,547	5,234,796	1.27	5,403	241
Michigan	1,158,904	59,202	64,924	.....	1,283,030	2,559,786	1.99	2,800	201
Missouri	3,417,140	438,211	80,629	.....	3,935,980	6,802,325	1.73	9,549	179
Montana	2,600,687	100,515	103,971	.....	2,805,173	4,913,191	1.75	3,350	209
New Mexico	3,047,328	34,141	53,385	742,835	3,877,689	6,230,871	1.61	4,178	283
North Dakota	347,806	143,797	15,082	.....	506,685	771,379	1.52	558	216
Ohio	16,397,457	1,960,719	484,508	431	18,843,115	21,250,642	1.13	45,401	108
Oklahoma	3,700,497	42,570	245,546	.....	3,988,613	8,204,015	2.06	8,078	205
Oregon	37,152	5,798	8,608	.....	51,558	143,556	2.78	190	266
Pennsylvania, bituminous	114,876,895	3,536,600	3,384,011	26,185,788	147,983,294	159,006,296	1.07	184,201	214
South Dakota	4,274	7,576	.....	.....	11,850	20,456	1.73	47	152
Tennessee	5,450,074	61,399	154,723	277,062	5,943,258	6,776,573	1.14	10,116	220
Texas	2,247,773	11,303	64,697	.....	2,323,773	3,922,459	1.69	4,635	237
Utah	2,355,687	43,199	100,739	603,411	3,103,036	4,935,454	1.59	4,112	210
Virginia	6,438,133	84,349	144,930	1,292,123	7,959,535	8,032,448	1.01	9,183	235
Washington	2,706,341	79,831	155,386	123,262	3,064,820	6,751,511	2.20	5,805	191
West Virginia	67,024,189	1,134,170	1,292,825	2,256,442	71,707,626	71,391,406	.99	78,963	201
Wyoming	6,093,804	88,336	293,153	.....	6,475,293	10,033,747	1.55	8,117	192
Total bituminous	364,505,279	12,962,580	10,444,455	34,791,656	422,703,970	493,309,244	1.17	583,506	195
Pennsylvania, anthracite	78,919,732	2,149,877	9,751,898	.....	90,831,507	188,181,399	2.07	179,679	245
Grand total	443,425,011	15,112,457	20,196,353	34,791,656	513,525,477	681,490,643	1.33	763,185	207

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Coal produced in the United States in 1915.

State.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Alabama	12,222,486	389,239	535,340	1,780,872	14,927,937	$19,066,043	$1.28	22,591	223
Alaska	.....	1,400	.....	.....	1,400	3,300	2.36	.....	.....
Arkansas	1,543,671	46,260	62,175	.....	1,652,106	2,950,456	1.79	3,751	149
California, Idaho, and Nevada	2,488	9,715	300	.....	12,503	32,054	2.56	36	285
Colorado	7,023,320	291,243	294,571	1,015,346	8,624,980	13,599,264	1.58	12,372	194
Georgia	90,523	1,396	7,200	35,377	134,496	231,861	1.72	368	197
Illinois	54,826,393	2,470,114	1,533,069	.....	58,829,576	64,622,471	1.10	75,610	179
Indiana	16,033,039	547,761	425,352	.....	17,006,152	18,637,476	1.10	22,777	179
Iowa	6,963,698	502,286	148,159	.....	7,614,143	13,577,608	1.78	15,549	220
Kansas	6,535,872	104,531	184,071	.....	6,824,474	11,360,630	1.66	13,260	184
Kentucky	19,821,392	586,864	495,313	458,105	21,361,674	21,494,008	1.01	27,980	186
Maryland	4,076,981	38,908	64,588	.....	4,180,477	5,330,845	1.28	5,664	242
Michigan	1,077,945	42,474	35,719	.....	1,156,138	2,372,797	2.05	2,569	198
Missouri	3,335,527	391,975	84,091	.....	3,811,593	6,595,918	1.73	9,173	186
Montana	2,561,239	105,924	122,592	.....	2,789,755	4,526,509	1.62	3,158	201
New Mexico	3,021,082	33,277	28,868	734,713	3,817,940	5,481,361	1.44	4,205	262
North Dakota	358,622	151,957	17,499	.....	528,078	766,072	1.45	590	219
Ohio	20,051,585	1,916,188	465,701	1,217	22,434,691	24,207,075	1.08	40,053	142
Oklahoma	3,406,533	39,482	247,565	.....	3,693,580	7,435,906	2.01	8,457	167
Oregon	30,142	2,272	6,817	.....	39,231	111,240	2.84	151	206
Pennsylvania, bituminous	119,176,343	3,231,909	3,048,515	32,498,370	157,955,137	167,419,705	1.06	174,593	226
South Dakota	3,794	6,799	.....	.....	10,593	16,384	1.55	35	155
Tennessee	5,175,592	71,071	167,560	316,138	5,730,361	6,479,916	1.13	8,948	220
Texas	2,016,286	13,266	59,356	.....	2,088,908	3,445,487	1.65	5,087	233
Utah	2,802,800	47,224	104,304	654,387	3,108,715	4,916,916	1.58	3,564	208
Virginia	6,943,235	82,210	135,799	966,352	8,122,596	7,962,934	.98	8,959	235
Washington	2,089,051	64,707	126,047	149,290	2,429,095	5,276,299	2.17	4,350	189
West Virginia	72,956,241	1,091,371	1,141,178	1,995,279	77,184,069	74,561,349	.97	75,882	208
Wyoming	6,225,211	71,885	256,932	.....	6,554,028	9,555,804	1.46	7,244	201
Total bituminous	379,876,591	12,353,708	9,798,681	40,595,446	442,624,426	502,037,688	1.13	557,456	203
Pennsylvania, anthracite	76,906,431	2,092,086	9,996,544	.....	88,995,061	184,653,498	2.07	176,552	230
Grand total	456,783,022	14,445,794	19,795,225	40,595,446	531,619,487	686,691,186	1.29	734,008	209

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Coal produced in the United States, 1911–1915, and increase or decrease in 1915.

State.	1911		1912		1913		1914	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.	Quantity (net tons).	Value.	Quantity (net tons).	Value.
Alabama	15,021,421	$19,079,949	16,100,600	$20,829,252	17,678,522	$23,083,724	15,598,422	$20,849,919
Arkansas	2,106,789	3,396,849	2,100,819	3,582,789	2,234,107	3,923,701	1,836,540	3,158,168
California and Alaska	11,647	23,297	11,333	26,441	26,911	95,178	[a] 13,974	[a] 39,821
Colorado	10,157,383	14,747,764	10,977,824	16,345,336	9,232,510	14,035,090	8,170,559	13,601,718
Georgia	[b] 165,330	[b] 246,448	227,703	338,926	255,626	361,319	166,498	239,462
Idaho and Nevada	1,821	4,872	[c] 2,964	[c] 9,313	2,177	5,285	(d)	(d)
Illinois	53,679,118	59,519,478	59,885,226	70,294,338	61,618,744	70,313,605	57,589,197	64,693,529
Indiana	14,201,355	15,326,808	15,285,718	17,480,546	17,165,671	19,001,881	16,641,132	18,290,928
Iowa	7,331,648	12,663,507	7,289,529	13,152,088	7,526,936	13,496,710	7,451,022	13,364,070
Kansas	6,178,728	9,478,572	6,986,182	11,324,130	7,202,210	12,036,292	6,860,988	11,238,253
Kentucky	14,049,703	14,008,458	16,490,521	16,854,207	19,616,600	20,516,749	20,382,763	20,852,463
Maryland	4,685,795	5,197,066	4,964,038	5,839,079	4,779,839	5,927,046	4,133,547	5,234,796
Michigan	1,476,074	2,791,461	1,206,230	2,399,451	1,231,786	2,455,227	1,283,030	2,559,786
Missouri	3,836,107	6,603,066	4,339,856	7,633,864	4,318,125	7,468,308	3,935,980	6,802,325
Montana	2,976,358	5,342,168	3,048,495	5,558,195	3,240,973	5,658,539	2,805,173	4,913,191
New Mexico	3,148,158	4,525,925	3,536,824	5,087,051	3,708,806	5,401,260	3,877,689	6,230,871
North Dakota	502,628	720,489	499,480	705,105	495,320	750,652	506,685	771,379
Ohio	30,759,986	31,810,123	34,528,727	37,083,363	36,200,527	39,948,058	18,843,115	21,250,642
Oklahoma	3,074,242	6,291,494	3,675,418	7,867,331	4,165,770	8,542,748	3,988,613	8,204,015
Oregon	46,661	108,033	41,637	108,276	46,063	116,724	51,558	143,556
Pennsylvania, bituminous	144,561,257	146,154,952	161,865,488	169,370,497	173,781,217	193,039,806	147,983,294	159,006,296
South Dakota					10,540	20,648	11,850	20,456
Tennessee	6,433,156	7,209,734	6,473,228	7,379,903	6,860,184	7,839,721	5,943,258	6,776,573
Texas	1,974,593	3,273,288	2,185,612	3,655,744	2,429,144	4,288,920	2,323,773	3,922,459
Utah	2,513,175	4,248,666	3,016,149	5,046,451	3,254,828	5,384,127	3,103,036	4,935,454
Virginia	6,864,667	6,254,804	7,846,638	7,518,576	8,828,068	8,952,653	7,959,535	8,032,448
Washington	3,572,815	8,174,170	3,360,932	8,042,871	3,877,891	9,243,137	3,064,820	6,751,511
West Virginia	59,831,580	53,670,515	66,786,687	62,792,234	71,254,136	71,822,804	71,707,626	71,391,408
Wyoming	6,744,864	10,508,863	7,368,124	11,648,088	7,393,066	11,510,045	6,475,293	10,033,747
Total bituminous	405,907,059	451,375,819	450,104,982	517,983,445	478,435,297	565,234,952	422,703,970	493,309,244
Pennsylvania, anthracite	90,464,067	175,189,392	84,361,598	177,622,626	91,524,922	195,181,127	90,821,507	188,181,399
Grand total	496,371,126	626,565,211	534,466,580	695,606,071	569,960,219	760,416,079	513,525,477	681,490,643

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State.	1915		Increase or decrease, 1915.			
	Quantity (net tons).	Value.	Quantity.		Value.	
			Net tons.	Per cent.	Dollars.	Per cent.
Alabama	14,927,937	$19,066,043	— 665,485	— 4.3	— 1,783,876	— 8.6
Arkansas	1,652,106	2,950,456	— 184,434	— 10.0	— 207,712	— 6.6
California and Alaska	[a] 13,903	[a] 35,354	— 71	— 0.5	— 4,467	— 11.2
Colorado	8,624,980	13,599,264	+ 454,421	+ 5.6	— 2,454	— .0
Georgia	134,496	231,861	— [f] 5,747	— 4.1	— 7,601	— 3.2
Idaho and Nevada	[d]	[d]	[d]		[d]	
Illinois	58,829,576	64,622,471	+ 1,240,379	+ 2.2	— 71,058	— .1
Indiana	17,006,152	18,637,476	+ 365,020	+ 2.2	+ 346,548	+ 1.9
Iowa	7,614,143	13,577,608	+ 163,121	+ 2.2	+ 213,538	+ 1.6
Kansas	6,824,474	11,360,630	— 36,514	— .5	+ 122,377	+ 1.1
Kentucky	21,361,674	21,494,008	+ 978,911	+ 4.8	+ 641,545	+ 3.1
Maryland	4,180,477	5,330,845	+ 46,930	+ 1.1	+ 96,049	+ 1.8
Michigan	1,156,138	2,372,797	— 126,892	— 9.9	— 186,989	— 7.3
Missouri	3,811,593	6,595,918	— 124,387	— 3.2	— 206,407	— 3.0
Montana	2,789,755	4,526,509	— 15,418	— .6	— 386,682	— 7.9
New Mexico	3,817,940	5,481,361	— 59,749	— 1.5	— 749,510	— 12.0
North Dakota	528,078	766,072	+ 21,393	+ 4.2	— 5,807	— .7
Ohio	22,434,601	24,207,075	+ 3,591,576	+ 19.1	+ 2,956,433	+ 13.9
Oklahoma	3,693,580	7,435,906	— 295,033	— 7.4	— 768,109	— 9.4
Oregon	39,231	111,240	— 12,327	— 23.9	— 32,316	— 22.5
Pennsylvania, bituminous	157,955,137	167,419,705	+ 9,971,843	+ 6.7	+ 8,413,409	+ 5.3
South Dakota	10,593	16,384	— 1,257	— 10.7	— 4,072	— 19.9
Tennessee	5,730,361	6,479,916	— 212,807	— 3.6	— 296,657	— 4.4
Texas	2,088,908	3,445,487	— 234,865	— 10.1	— 476,972	— 12.2
Utah	3,108,715	4,916,916	+ 5,679	+ .2	— 18,538	— .4
Virginia	8,122,596	7,962,934	+ 163,061	+ 2.1	— 69,514	— .9
Washington	2,429,095	5,276,299	— 635,725	— 20.7	— 1,475,212	— 21.9
West Virginia	77,184,099	74,561,349	+ 5,476,443	+ 7.6	+ 3,169,941	+ 4.4
Wyoming	6,554,028	9,555,804	+ 78,735	+ 1.2	— 477,943	— 4.8
Total bituminous	442,624,426	502,037,688	+ 19,920,456	+ 4.7	+ 8,728,444	+ 1.8
Pennsylvania, anthracite	88,995,061	184,653,498	— 1,826,446	— 2.0	— 3,527,901	— 1.9
Grand total	531,619,487	686,691,186	+ 18,094,010	+ 3.5	+ 5,200,543	+ .8

[a] California, Idaho, and Nevada.
[b] Includes North Carolina.
[c] Idaho only.
[d] Included with California.
[e] California, Alaska, Idaho, and Nevada.
[f] Excludes refuse (26,255 tons in 1915) from washery, included in total production in 1914.

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Coal produced in the United States from 1807 to the end of 1915, in net tons.

Year.	Pennsylvania anthracite.	Bituminous.	Total.	Year.	Pennsylvania anthracite.	Bituminous.	Total.
1807–1820	12,000	3,000	15,000	1871	19,342,057	27,543,023	46,885,080
				1872	24,233,166	27,220,233	51,453,399
1821	1,322		1,322	1873	26,152,837	31,449,643	57,602,480
1822	4,583	54,000	58,583	1874	24,818,790	27,787,130	52,605,920
1823	8,563	60,000	68,563	1875	22,485,766	29,862,554	52,348,320
1824	13,685	67,040	80,725				
1825	42,988	75,000	117,988	1876	22,793,245	30,486,755	53,280,000
				1877	25,660,316	34,841,444	60,501,760
1826	59,194	88,720	147,914	1878	21,689,682	36,245,918	57,935,600
1827	78,151	94,000	172,151	1879	30,207,793	37,898,006	68,105,799
1828	95,500	100,408	195,908	1880	28,649,812	42,831,758	71,481,570
1829	138,086	102,000	240,086				
1830	215,272	104,800	320,072	1881	31,920,018	53,961,012	85,881,030
				1882	35,121,256	68,429,933	103,551,189
1831	217,842	120,100	337,942	1883	38,456,845	77,250,680	115,707,525
1832	447,550	146,500	594,050	1884	37,156,847	82,998,704	120,155,551
1833	600,907	133,750	734,657	1885	38,335,974	72,824,321	111,160,295
1834	464,015	136,500	600,515				
1835	690,854	134,000	824,854	1886	39,035,446	74,644,981	113,680,427
				1887	42,088,197	88,562,314	130,650,511
1836	842,832	142,000	984,832	1888	46,619,564	102,040,093	148,659,657
1837	1,071,151	182,500	1,253,651	1889	45,546,970	95,682,543	141,229,513
1838	910,075	445,452	1,355,527	1890	46,468,641	111,302,322	157,770,963
1839	1,008,322	552,038	1,560,360				
1840	967,108	1,102,931	2,070,039	1891	50,665,431	117,901,238	168,566,669
				1892	52,472,504	126,856,567	179,329,071
1841	1,182,441	1,108,700	2,291,141	1893	53,967,543	128,385,231	182,352,774
1842	1,365,563	1,244,494	2,610,057	1894	51,921,121	118,820,405	170,741,526
1843	1,556,753	1,504,121	3,060,874	1895	57,999,337	135,118,193	193,117,530
1844	2,009,207	1,672,045	3,681,252				
1845	2,480,032	1,829,872	4,309,904	1896	54,346,081	137,640,276	191,986,357
				1897	52,611,680	147,617,519	200,229,199
1846	2,887,815	1,977,707	4,865,522	1898	53,382,644	166,593,623	219,976,267
1847	3,551,005	1,735,062	5,286,067	1899	60,418,005	193,323,187	253,741,192
1848	3,805,942	1,968,032	5,773,974	1900	57,367,915	212,316,112	269,684,027
1849	3,995,334	2,453,497	6,448,831				
1850	4,138,164	2,880,017	7,018,181	1901	67,471,667	225,328,149	293,299,816
				1902	41,378,595	260,216,844	301,595,439
1851	5,481,065	3,253,460	8,734,525	1903	74,607,068	282,749,348	357,356,416
1852	6,151,957	3,664,707	9,816,664	1904	73,156,709	278,659,689	351,816,398
1853	6,400,426	4,169,862	10,570,288	1905	77,659,850	315,062,785	392,722,635
1854	7,394,875	4,582,227	11,977,102				
1855	8,141,754	4,784,919	12,926,673	1906	71,282,411	342,874,867	414,157,278
				1907	85,604,312	394,759,112	480,363,424
1856	8,534,779	5,012,146	13,546,925	1908	83,268,754	332,573,944	415,842,698
1857	8,186,567	5,153,622	13,340,189	1909	81,070,359	379,744,257	460,814,616
1858	8,426,102	5,548,376	13,974,478	1910	84,485,236	417,111,142	501,596,378
1859	9,619,771	6,013,404	15,633,175				
1860	8,115,842	6,494,200	14,610,042	1911	90,464,067	405,907,059	496,371,126
				1912	84,361,598	450,104,982	534,466,580
1861	9,799,654	6,688,358	16,488,012	1913	91,524,922	478,435,297	569,960,219
1862	9,695,110	7,790,725	17,485,835	1914	90,821,507	422,703,970	513,525,477
1863	11,785,320	9,533,742	21,319,062	1915	88,995,061	442,624,426	531,619,487
1864	12,538,649	11,066,474	23,605,123				
1865	11,891,746	11,900,427	23,792,173		2,626,512,578	8,262,792,323	10,889,304,901
1866	15,651,183	13,352,400	29,003,583				
1867	16,002,109	14,722,313	30,724,422				
1868	17,003,405	15,858,555	32,861,960				
1869	17,083,134	15,821,226	32,904,360				
1870	15,664,275	17,371,305	33,035,580				

RANK OF COAL-PRODUCING STATES.

In the following table the States are arranged according to their rank as coal producers, first, as to quantity of coal mined and, second, as to value of the product. Pennsylvania is, of course, the leading State in both quantity and value of coal produced, and West Virginia and Illinois follow in the order of rank. Among the more important States the only change to be noted is that Ohio regained fourth place in rank as regards quantity after a lapse of one year to fifth place. There were several changes in rank, as regards both quantity and value, among the less important States, but the order remains remarkably uniform from year to year.

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Rank of coal-producing States in 1914 and 1915.

1914.

Production.				Value.			
Rank.	State.	Quantity (net tons).	Percentage of total production.	Rank.	State.	Value.	Percentage of total value.
1	Pennsylvania:			1	Pennsylvania:		
	Anthracite	90,821,507	17.7		Anthracite	$188,181,399	27.6
	Bituminous	147,983,294	28.8		Bituminous	159,006,296	23.3
2	West Virginia	71,707,626	14.0	2	West Virginia	71,391,408	10.5
3	Illinois	57,589,197	11.2	3	Illinois	64,693,529	9.5
4	Kentucky	20,382,763	4.0	4	Ohio	21,250,642	3.1
5	Ohio	18,843,115	4.0	5	Kentucky	20,852,463	3.0
6	Indiana	16,641,132	3.2	6	Alabama	20,849,919	3.0
7	Alabama	15,593,422	3.0	7	Indiana	18,290,928	2.7
8	Colorado	8,170,559	1.6	8	Colorado	13,601,718	2.0
9	Virginia	7,959,535	1.5	9	Iowa	13,364,070	2.0
10	Iowa	7,451,022	1.4	10	Kansas	11,238,253	1.6
11	Kansas	6,860,988	1.3	11	Wyoming	10,033,747	1.5
12	Wyoming	6,475,293	1.2	12	Oklahoma	8,204,015	1.2
13	Tennessee	5,943,258	1.2	13	Virginia	8,032,448	1.2
14	Maryland	4,133,547	.8	14	Missouri	6,802,325	1.0
15	Oklahoma	3,988,613	.8	15	Tennessee	6,776,573	1.0
16	Missouri	3,935,980	.8	16	Washington	6,751,511	1.0
17	New Mexico	3,877,689	.7	17	New Mexico	6,230,871	.9
18	Utah	3,103,036	.6	18	Maryland	5,234,796	.8
19	Washington	3,064,820	.6	19	Utah	4,935,454	.7
20	Montana	2,805,173	.5	20	Montana	4,913,191	.7
21	Texas	2,323,773	.4	21	Texas	3,922,459	.6
22	Arkansas	1,836,540	.3	22	Arkansas	3,158,158	.5
23	Michigan	1,283,030	.2	23	Michigan	2,559,786	.4
24	North Dakota	506,635	.1	24	North Dakota	771,379	.1
25	Georgia	166,498		25	Georgia	239,462	
26	Oregon	51,558		26	Oregon	143,556	
27	California, Idaho, and Nevada	13,974	.1	27	California, Idaho, and Nevada	39,821	.1
28	South Dakota	11,850		28	South Dakota	20,456	
		513,525,477	100.0			681,490,642	100.0

1915.

1	Pennsylvania:			1	Pennsylvania:		
	Anthracite	88,995,061	16.8		Anthracite	$184,653,498	26.9
	Bituminous	157,955,137	29.7		Bituminous	167,419,705	24.4
2	West Virginia	77,184,069	14.5	2	West Virginia	74,561,349	10.8
3	Illinois	58,829,576	11.1	3	Illinois	64,622,471	9.4
4	Ohio	22,434,091	4.2	4	Ohio	24,207,075	3.5
5	Kentucky	21,361,674	4.0	5	Kentucky	21,494,008	3.1
6	Indiana	17,006,152	3.2	6	Alabama	19,066,043	2.8
7	Alabama	14,927,037	2.8	7	Indiana	18,637,476	2.7
8	Colorado	8,624,980	1.6	8	Colorado	13,599,364	2.0
9	Virginia	8,122,506	1.5	9	Iowa	13,577,008	2.0
10	Iowa	7,614,143	1.4	10	Kansas	11,360,630	1.6
11	Kansas	6,824,474	1.3	11	Wyoming	9,555,904	1.4
12	Wyoming	6,554,028	1.2	12	Virginia	7,962,934	1.2
13	Tennessee	5,730,361	1.1	13	Oklahoma	7,435,906	1.1
14	Maryland	4,180,477	.8	14	Missouri	6,595,918	1.0
15	New Mexico	3,817,940	.7	15	Tennessee	6,479,916	.9
16	Missouri	3,811,593	.7	16	New Mexico	5,481,361	.8
17	Oklahoma	3,693,580	.7	17	Maryland	5,330,845	.8
18	Utah	3,108,715	.6	18	Washington	5,276,199	.8
19	Montana	2,789,755	.5	19	Utah	4,916,916	.7
20	Washington	2,429,095	.5	20	Montana	4,526,509	.7
21	Texas	2,088,908	.4	21	Texas	3,445,487	.5
22	Arkansas	1,652,106	.3	22	Arkansas	2,950,456	.4
23	Michigan	1,156,138	.2	23	Michigan	2,372,797	.3
24	North Dakota	528,078	.1	24	North Dakota	766,072	.1
25	Georgia	134,496		25	Georgia	231,961	
26	Oregon	39,231		26	Oregon	111,340	
27	California, Idaho, and Nevada	12,503	.1	27	California, Idaho, and Nevada	32,054	.1
28	South Dakota	10,593		28	South Dakota	16,384	
29	Alaska	1,400		29	Alaska	3,300	
		531,619,487	100.0			686,691,186	100.0

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LABOR STATISTICS.

Labor is the item of largest importance in the business of producing coal. It is generally considered that the mining rate—that is, the contract price paid the miner for loading out the coal—is about one-half the cost of the coal on board the railroad cars, or one-half the mining cost. When to the miner's compensation is added the cost of the day labor in and about the mines, it is seen that considerably more than one-half the total cost of a ton of coal is due to labor.

The average daily output per employee varies in different districts and is determined by a number of factors, among the most important of which are thickness of coal bed, use of mining machines, efficiency of labor, and particularly (curve A) efficiency of management. As shown by the data in the table on page 363 and by figure 17, the average daily output has exhibited a steady upward tendency and in the period from 1900 to 1915 has declined but four times—in 1901, in 1903, an abnormal year in coal mining because of the anthracite strike in 1902, and in 1907 and 1913, both record years for the coal industry as regards quantity of output. Undoubtedly this improvement is due to better methods of mining, involving not only the greater use of cutting machines but also improved haulage systems and other mechanical and engineering features. When the demand for coal is slack and prices fall off there is incentive to conserve labor; but when every effort is directed toward increasing output to meet strong demand at rising prices, efficiency is allowed to slacken. Such conditions account for the decline in the quantity of daily output per employee in 1907 and 1913.

The average annual output per employee depends upon the daily rate and the number of active days. The best efforts of all concerned can not greatly affect the daily rate within any short period, and record outputs are therefore obtained by increasing the number of men and by working the mines a greater number of days. The total number of men engaged in mining bituminous coal has, with a few slight exceptions, shown increase in each succeeding year from 1900 to 1914, and the average number of days the men worked has varied up or down with the increase or decrease in the total production. As shown by figure 17, there is a very close resemblance in shape between the curves of total production, days (curve E, upper), and average annual output (curve C) between 1900 and 1914 (curve B).

The record for 1915 presents a striking exception to the general tendency, for although there was (compared with 1914) an increase in total output, accompanied by a greater number of active days, the number of employees decreased notably. When considered in connection with the statistics of previous years, as shown graphically in figure 17, this decrease is seen to be abnormal and indicates at least the beginning of a shortage in labor, substantiating the views of those in the industry that such a shortage was imminent during the closing months of 1915 and was not seriously felt only because of the halt in production caused by the shortage in cars.

With the increases of wages that were made in April, 1916, and the opportunity for more than the usual number of days' work, the coal miners are in a position to share very fully in the general prosperity of 1916.

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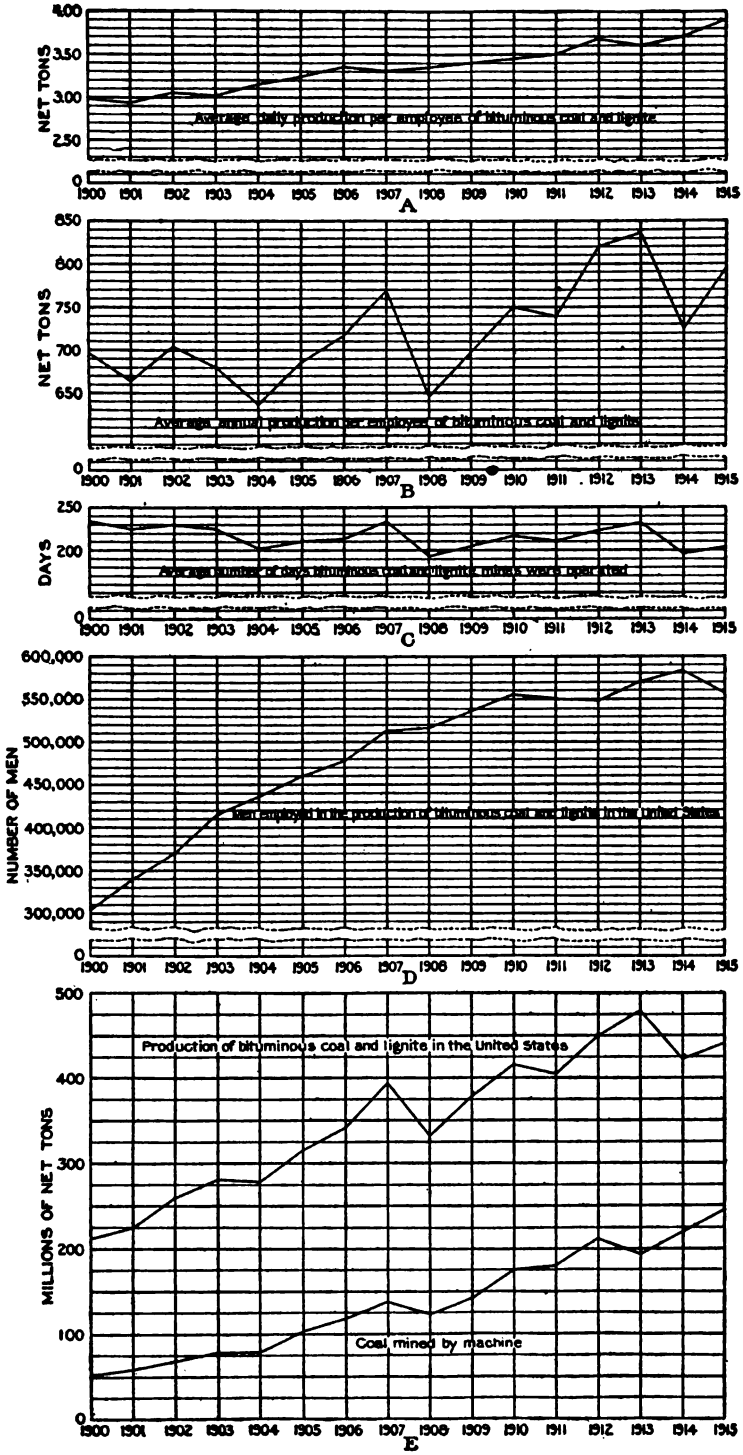
NET TONS
Average daily production per employee of bituminous coal and lignite
A
NET TONS
Average annual production per employee of bituminous coal and lignite
B
DAYS
Average number of days bituminous coal and lignite mines were operated
C
NUMBER OF MEN
Men employed in the production of bituminous coal and lignite in the United States
D
MILLIONS OF NET TONS
Production of bituminous coal and lignite in the United States
Coal mined by machine
E

FIGURE 17.—Graphic representation of production and labor statistics of bituminous coal and lignite in the United States for the period 1900–1915.

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Statistics of labor employed in coal mines of the United States, 1911–1915.

State.	1911		1912		1913		1914		1915	
	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.	Number of days active.	Average number employed.
Alabama	227	22,707	245	22,613	255	24,552	226	24,042	223	22,501
Arkansas	133	5,657	157	4,536	174	4,652	143	4,339	149	3,751
California	[a] 265	[a] 60	[a] 134	[a] 52	[a] 302	[a] 40	[b] 291	[b] 43	[b] 285	[b] 36
Colorado	207	14,316	227	13,000	229	11,990	244	10,098	194	12,372
Georgia	[c] 277	[c] 514	[c] 254	[c] 450	261	500	207	355	197	368
Idaho	[d] 228	[d] 13	[d] 253	[d] 20	[d] 183	[d] 12	[e]	[e]	[e]	[e]
Illinois	188	76,600	194	78,098	189	79,529	173	79,499	179	75,610
Indiana	182	21,182	182	21,651	190	22,235	168	23,175	179	22,777
Iowa	203	16,599	188	16,370	195	15,757	204	16,057	220	15,549
Kansas	190	11,357	202	11,646	197	12,479	192	12,448	184	13,260
Kentucky	201	21,921	201	24,304	212	26,332	187	28,764	186	27,960
Maryland	243	5,881	259	6,162	248	5,645	241	5,403	242	5,664
Michigan	218	3,323	183	3,113	188	3,305	201	2,800	198	2,569
Missouri	182	10,259	206	9,704	187	10,418	179	9,549	186	9,173
Montana	220	3,866	220	3,440	228	3,630	209	3,350	201	3,158
New Mexico	230	4,007	274	3,928	289	4,329	283	4,178	262	4,205
North Dakota	229	640	232	622	221	641	216	558	219	590
Ohio	179	46,035	201	45,527	206	45,815	108	45,401	142	40,053
Oklahoma	156	8,790	174	8,785	197	9,044	205	8,078	167	8,457
Oregon	179	189	239	222	283	203	266	190	206	151
Pennsylvania, bituminous	233	168,199	252	165,144	267	172,196	214	184,201	226	174,593
South Dakota					137	48	152	47	155	35
Tennessee	232	10,703	234	10,309	241	11,238	220	10,116	220	8,948
Texas	226	5,353	230	5,127	253	5,101	237	4,635	233	5,057
Utah	236	3,060	285	3,328	273	4,158	210	4,112	208	3,564
Virginia	261	7,392	251	8,678	280	9,162	235	9,183	235	8,959
Washington	225	6,498	226	5,519	260	5,794	191	5,805	169	4,850
West Virginia	221	66,730	266	68,248	234	74,746	201	78,963	208	75,882
Wyoming	230	7,924	238	8,036	232	8,331	192	8,117	201	7,244
Total bituminous	211	549,775	223	548,632	232	571,882	195	583,506	203	557,456
Pennsylvania, anthracite	246	172,585	231	174,030	257	175,745	245	179,679	230	176,552
Grand total	220	722,360	225	722,662	238	747,627	207	763,185	209	734,008

[a] Includes Alaska. [b] Includes Idaho and Nevada. [c] Includes North Carolina. [d] Includes Nevada. [e] Included with California.

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Coal produced per man employed, 1890–1915.

Year.	Anthracite.				Bituminous.			
	Men employed.	Days worked.	Average tonnage per man per day.	Average tonnage per man per year.	Men employed.	Days worked.	Average tonnage per man per day.	Average tonnage per man per year.
1890	126,000	200	1.85	369	192,204	226	2.56	579
1891	126,350	203	1.98	401	205,803	223	2.57	573
1892	129,050	198	2.06	407	212,893	219	2.72	596
1893	132,944	197	2.06	406	230,365	204	2.73	557
1894	131,603	190	2.08	395	244,603	171	2.84	486
1895	142,917	196	2.07	406	239,962	194	2.90	563
1896	148,991	174	2.10	365	244,171	192	2.94	564
1897	149,884	150	2.34	351	247,817	196	3.04	596
1898	145,504	152	2.41	367	255,717	211	3.09	651
1899	139,608	173	2.50	433	271,027	234	3.05	713
1900	144,206	166	2.40	398	304,375	234	2.98	697
1901	145,309	196	2.37	464	340,235	225	2.94	664
1902	148,141	116	2.40	279	370,056	230	3.06	703
1903	150,483	206	2.41	496	415,777	225	3.02	680
1904	155,861	200	2.35	469	437,832	202	3.15	637
1905	165,406	215	2.18	470	460,629	211	3.24	684
1906	162,355	195	2.25	439	478,425	213	3.36	717
1907	167,234	220	2.33	512	513,258	234	3.29	769
1908	174,174	200	2.39	478	516,264	193	3.34	644
1910	169,497	229	2.17	498	555,533	217	3.46	751
1911	172,585	246	2.13	524	549,775	211	3.50	738
1912	174,030	231	2.10	485	548,632	223	3.68	820
1913	175,745	257	2.02	520	571,882	232	3.61	837
1914	179,679	245	2.06	505	583,506	195	3.71	724
1915	176,552	230	2.19	504	557,456	203	3.91	794

Coal produced per man and average number of days per year in 1914 and 1915.

State.	1914			1915		
	Days worked.	Average tonnage.		Days worked.	Average tonnage.	
		Per year.	Per day.		Per year.	Per day.
Alabama	226	649	2.87	223	661	2.96
Arkansas	143	423	2.96	149	440	2.95
Colorado	244	809	3.32	194	697	3.60
Illinois	173	724	4.18	179	778	4.35
Indiana	168	718	4.27	179	747	4.17
Iowa	204	464	2.27	220	490	2.23
Kansas	192	551	2.87	184	515	2.80
Kentucky	187	709	3.79	186	764	4.11
Maryland	241	765	3.17	242	739	3.05
Michigan	201	458	2.28	198	450	2.27
Missouri	179	412	2.30	186	416	2.24
Montana	209	837	4.00	201	883	4.39
New Mexico	283	928	3.28	262	908	3.47
North Dakota	216	908	4.20	219	895	4.09
Ohio	108	415	3.84	142	560	3.94
Oklahoma	205	494	2.41	167	437	2.62
Pennsylvania:						
Anthracite	245	505	2.06	230	504	2.19
Bituminous	214	803	3.75	226	905	4.00
Tennessee	220	588	2.67	220	640	2.91
Texas	237	501	2.11	233	411	1.76
Utah	210	755	3.60	208	872	4.19
Virginia	235	867	3.69	235	907	3.86
Washington	191	528	2.76	169	501	2.96
West Virginia	201	908	4.52	208	1,017	4.89
Wyoming	192	798	4.16	201	905	4.50

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In most of the bituminous coal mines of the United States the length of the working day is 8 hours. In 1915, out of a total of 5,076 mines for which the number of hours worked per day were reported, 3,018, or 59.5 per cent, worked 8 hours; 910, or 17.9 per cent, worked 9 hours; and 1,148, or 22.6 per cent, worked 10 hours. The corresponding percentages in 1914 for 5,189 mines were 60, 17.5, and 22.5. The 8-hour mines employed in 1915 a total of 325,308 men; the 9-hour mines, 92,838 men; and the 10-hour mines, 127,268 men. In comparing the figures for 1914 and 1915 it will be noted that although there was a decrease in the total number of men employed, the number of mines and the men working 9 hours showed an increase, the States of Alabama, Kentucky, Ohio, and West Virginia being noteworthy examples. Most of the same States show corresponding decreases in 8-hour and 10-hour operations, and there is nothing in these statistics therefore to indicate whether the tendency was toward an increase of working hours from 8 to 9 or a decrease from 10 to 9. Other evidence points to the gradual shortening of length of working day, and the inference is that fewer 8-hour mines were operated rather than that any increased their length of working day.

It should be remembered, however, that when the length of the working day is stated, reference is made to the number of hours the mines are supposed to have been in operation and not to the number of hours worked by the miners. In both the anthracite and the bituminous fields practically all the coal is mined by contract at an agreed rate per ton or other basis of payment. The miner is an independent contractor and is not obliged to put in a certain number of hours at his working place. The figures in the following table really indicate the number of hours the men were given opportunity to work and do not mean that all the employees worked 8, 9, or 10 hours, as the case may have been.

Since the settlement of the anthracite strike of 1902 and until the new agreement in 1916 the mines in that region have been operated on a 9-hour basis, with the exception of engineers and pumpmen, who work 8 hours, and of the miners, who work by contract.

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Length of working day in coal mines in the United States in 1914 and 1915.

1914.

State.	8 hours.		9 hours.		10 hours.		All others.
	Mines.	Men.	Mines.	Men.	Mines.	Men.	Men.
Alabama	14	646	24	3,456	150	18,115	1,735
Arkansas	53	4,314	.....	.....	.....	.....	25
Colorado	137	9,496	1	198	1	55	349
Illinois	455	78,672	9	99	.....	.....	728
Indiana	193	21,172	3	14	1	85	1,904
Iowa	175	15,514	2	8	1	4	531
Kansas	121	12,240	.....	.....	.....	.....	208
Kentucky	63	5,438	64	5,856	206	17,120	350
Maryland	5	55	1	17	51	5,261	70
Michigan	15	2,070	.....	.....	.....	.....	730
Missouri	165	9,366	2	23	2	33	127
Montana	49	3,193	.....	.....	.....	.....	157
New Mexico	27	3,794	3	363	2	9	12
North Dakota	14	51	10	91	20	403	13
Ohio	531	43,718	11	189	3	19	1,475
Oklahoma	82	7,806	.....	.....	2	74	198
Oregon	4	169	.....	.....	.....	.....	21
Pennsylvania (bituminous)	819	103,291	291	32,293	263	44,643	3,974
Tennessee	7	280	77	6,612	33	3,166	58
Texas	25	2,707	2	160	17	1,220	539
Utah	22	4,112	.....	.....	.....	.....	.....
Virginia	3	109	11	1,276	49	7,798	.....
Washington	53	5,751	.....	.....	1	34	20
West Virginia	35	3,144	394	36,612	361	37,826	1,381
Wyoming	53	7,706	.....	.....	1	2	409
	3,120	344,814	905	87,357	1,164	135,876	15,014

1915.

Alabama	13	369	44	4,402	133	17,109	711
Arkansas	58	3,589	.....	.....	.....	.....	162
Colorado	153	12,259	1	2	.....	.....	111
Illinois	416	74,619	6	32	.....	.....	959
Indiana	193	22,364	4	12	7	69	332
Iowa	167	15,308	3	24	.....	.....	217
Kansas	134	12,870	.....	.....	.....	.....	390
Kentucky	58	5,249	75	7,325	188	14,793	593
Maryland	5	142	2	8	48	5,254	260
Michigan	17	2,569	.....	.....	.....	.....	.....
Missouri	161	8,906	2	53	2	38	176
Montana	36	3,108	.....	.....	.....	.....	50
New Mexico	35	4,042	2	146	1	8	9
North Dakota	19	76	7	27	17	471	16
Ohio	500	38,410	19	267	3	30	1,336
Oklahoma	88	7,833	.....	.....	2	49	575
Oregon	3	92	.....	.....	.....	.....	59
Pennsylvania (bituminous)	779	90,999	278	40,159	275	40,646	2,789
Tennessee	4	229	61	5,412	28	2,694	613
Texas	19	2,235	8	301	16	1,458	393
Utah	21	3,556	.....	.....	.....	.....	8
Virginia	.....	.....	8	200	56	8,759	.....
Washington	52	4,809	.....	.....	.....	.....	41
West Virginia	39	3,741	389	34,446	371	35,896	1,799
Wyoming	48	7,234	1	2	1	4	4
	3,018	325,308	910	92,838	1,148	127,268	11,603

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STRIKES AND SUSPENSIONS.

Within recent years the time lost because of labor strikes has not interfered except locally with the production of coal. The possible effect of a shutdown of the mines in the even years during the progress of wage negotiations in the bituminous fields is usually discounted in advance by the storage of coal, and in other years the total possible working days lost because of labor disaffection amounts to but 1 or 2 per cent of the total active days.

In 1915 there were 15,048 men who were affected for a total of more than 1,700,000 days in Ohio, where not all of the difficulties arising from the serious strike of 1914 had yet been adjusted. In the other States the strikes in 1915 were of comparatively small consequence.

Labor strikes in the coal mines of the United States in 1914 and 1915.

State.	1914			1915		
	Number of men on strike.	Total days lost.	Average number of days lost per man.	Number of men on strike.	Total days lost.	Average number of days lost per man.
Alabama	320	3,940	12	175	1,290	7
Arkansas	1,415	159,854	113	925	20,304	22
Colorado	4,418	1,090,025	247	90	13,500	150
Illinois	23,506	970,466	41	5,251	276,458	53
Indiana	8,052	302,855	38	1,472	21,361	15
Iowa	2,642	76,791	29	1,067	5,229	5
Kansas	2,673	45,257	17	1,716	17,425	10
Kentucky	2,250	82,919	37	1,045	16,455	16
Maryland	91	1,547	17			
Missouri	1,162	56,536	49	939	4,597	5
Montana	171	1,271	7	183	1,084	6
Ohio	40,577	6,452,762	159	15,048	1,722,013	114
Oklahoma	1,286	39,500	31	1,013	4,485	4
Oregon	21	798	38			
Pennsylvania, bituminous	36,613	1,052,005	29	5,583	78,446	14
Texas	221	693	3	230	760	3
Utah	150	1,800	12			
Virginia				7	7	1
Washington	459	25,410	55			
West Virginia	9,330	466,768	50	1,902	66,698	35
Wyoming	248	2,727	11	219	2,628	12
Total bituminous	135,605	10,833,924	80	36,865	2,252,740	61
Pennsylvania, anthracite	26,115	179,743	7	30,325	214,691	7

Summary of labor strikes in the coal mines of the United States, 1899–1914.

Year.	Number of men on strike.	Total working days lost.	Average number of days lost per man.
1899	45,981	2,124,154	46
1900	131,973	4,878,102	37
1901 [a]	20,593	733,802	35
1902	200,452	16,672,217	83
1903 [a]	47,481	1,341,031	28
1904	77,661	3,382,830	44
1905	37,542	796,735	21
1906	372,343	19,201,348	51.5
1907 [a]	32,540	462,392	14
1908 [a]	145,145	5,449,988	38
1909 [a]	24,763	723,634	29
1910	218,493	19,260,524	88
1911	41,413	983,737	24
1912	311,056	12,527,305	40
1913	135,395	3,049,412	22.5
1914	161,720	11,013,667	68
1915	67,190	2,467,431	37

[a] Bituminous mines only.

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COAL MINED BY MACHINES.

As shown graphically in diagram E, figure 17, the proportion of machine-mined bituminous coal to the total output has increased each year. In 1915 the proportion was 55 per cent, twice that of 1903, 12 years before, and the number of tons so mined in 1915 was more than three times that in 1903. Although no particular conclusion is warranted by the comparison, it is interesting to note that among the nine States ranking highest in order of bituminous production—that is, producing 8,000,000 tons or more (see p. 359)—all but two, Alabama and Colorado, showed more than half mined by machines; and that among all the other States only two, Montana and Michigan, recorded like proportions. Ohio continues to lead, with nearly 90 per cent of the total output recovered by machines in 1915. The percentage in Kentucky and Michigan was over 80, and in Virginia, West Virginia, and Illinois 60 or more.

There was a notable decrease in the number of machines in use, 15,692 in 1915, compared with 16,507 in 1914 and 16,379 in 1913. Indicating, as it does, that fewer men were available to use the machines (for the actual number of machines at the mines can not be considered to have decreased), this decrease in the number in use furnishes further evidence of labor shortage and at the same time shows how production may be maintained even under such a condition.

The average output per machine in 1915 was 15,501 tons, a quantity greater by 700 tons than the previous record of 1913. The statistics covering the coal mined by machines are shown in the following table:

Bituminous coal mined by machines in the United States, 1914 and 1915.

State.	Machines in use.		Quantity mined by machines (net tons).		Percentage of total product mined by machines.	
	1914	1915	1914	1915	1914	1915
Alabama	362	373	4,937,222	5,285,133	31.7	35.4
Arkansas	28	24	351,838	391,573	19.1	23.7
California and Oregon	[a] 2	3	[a] 500	2,272	[a] 4.3	4.6
Colorado	306	299	2,502,558	2,628,300	30.6	30.5
Illinois	1,812	1,787	32,640,528	36,011,461	56.7	61.2
Indiana	751	660	9,360,683	9,930,445	56.2	58.4
Iowa	46	45	308,284	414,606	4.1	5.5
Kansas	9	9	39,194	43,394	.6	.6
Kentucky	1,383	1,399	15,731,332	17,468,502	77.2	81.8
Maryland	10	12	110,065	221,651	2.7	5.4
Michigan	107	107	998,935	973,151	77.8	84.2
Missouri	88	97	750,037	861,957	19.0	22.6
Montana	99	100	1,213,051	1,534,064	43.3	55.0
New Mexico	45	42	619,472	644,698	16.0	16.9
North Dakota	14	14	208,199	203,775	41.1	38.6
Ohio	1,669	1,459	16,147,630	20,008,259	85.7	89.2
Oklahoma	116	140	1,053,526	1,122,512	26.4	30.4
Pennsylvania	6,326	5,935	79,657,459	87,752,569	53.8	55.6
Tennessee	194	193	1,377,984	1,507,425	23.2	26.3
Texas	13	10	27,971	34,103	1.2	1.6
Utah	68	67	944,421	1,540,737	30.4	49.6
Virginia	182	186	4,092,810	5,130,827	51.4	63.2
Washington	72	73	328,043	310,598	10.7	12.8
West Virginia	2,607	2,479	42,263,394	46,288,657	58.9	60.0
Wyoming	198	179	2,734,151	2,923,582	42.2	44.6
	16,507	15,692	218,399,287	243,237,551	[b] 51.7	[b] 55.0

[a] California only. [b] Average.

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Bituminous coal mined by machines in the United States, 1891–1915.

Year.	Machines in use.	Quantity mined by machines (net tons).	Average production for each machine (net tons).	Year.	Machines in use.	Quantity mined by machines (net tons).	Average production for each machine (net tons).
1891	545	6,211,732	11,398	1906	10,212	118,847,527	11,638
1896	1,446	16,424,932	11,373	1907	11,144	138,547,823	12,432
1897	1,956	22,649,220	11,579	1908	11,560	123,183,334	10,648
1898	2,622	32,413,144	12,362	1909	13,049	142,496,878	10,920
1899	3,125	43,963,933	14,068	1910	13,254	174,012,293	13,127
1900	3,907	52,784,523	13,510	1911	13,829	178,158,236	12,854
1901	4,341	57,843,335	13,325	1912	15,298	210,538,822	13,763
1902	5,418	69,611,582	12,848	1913	16,379	242,421,713	14,801
1903	6,658	77,974,894	11,712	1914	16,507	218,399,287	13,231
1904	7,663	78,606,997	10,258	1915	15,692	243,237,551	15,501
1905	9,184	103,396,452	11,258				

The quantities of machine-mined Pennsylvania anthracite given in the following table were compiled by the Anthracite Bureau of Information and are published here through the courtesy of that organization. These statistics cover the years 1911 to 1915, inclusive, and it appears that prior to 1911 the quantity so mined was negligible. Although mining conditions, particularly in the southern part of the anthracite field, are unfavorable to the use of the types of machines now employed in the soft-coal regions and the attitude of labor has not encouraged their introduction, it seems inevitable that the operators, in the face of increasing cost of mining and with an economic limit beyond which, because of competition with soft coal, gas, and coke, prices can not be further raised, will within the next few years be obliged to adopt and adapt mining machines, for by no other means can material economies in cost of production of anthracite be effected.

Anthracite coal mined by machines, 1911–1915.

Year.	Quantity (gross tons).	Year.	Quantity (gross tons).
1911	62,417	1914	818,389
1912	219,836	1915	1,167,639
1913	496,229		

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MINING METHODS.

The term "mining method," as used here, refers to the manner in which the coal is broken down in the mine, and not to the system of mining, as by room and pillar or long wall. In the mine the coal is either blasted from a solid face—shot from the solid—as in hard-rock mining, or is shot loose or otherwise broken down after a preliminary cut into the coal has been made. This cut may be made by hand or by machine. Underground methods are therefore classified as shot from the solid, mined by hand, and mined by machines. An increasing quantity of coal is being recovered each year by stripping the cover from the bed in open pits by steam shovels. The bed thus exposed is for the most part shattered by powder and shoveled into cars by hand, although in places it is picked up directly by small steam shovels.

Opposition to shooting from the solid has developed, because it is injurious to the mining property in that the unusual charges of powder weaken the roof and pillars, which increases the liability to falls of roof and coal, the most prolific cause of fatal accidents to coal miners. Another objection to this method is that the heavy charges of powder required to blow down the coal where it has not been previously undercut or sheared, result in the production of a much higher proportion of fine coal and render the lump coal so friable that it disintegrates in handling and in transportation. With the growing use of mechanical stokers and of powdered coal, the latter objection is losing much of its force, but the danger attending the method has been in no wise diminished, and it is forbidden by law in some of the coal-mining States.

There was a slight increase in the proportion of total output shot from the solid in 1915 compared with 1914, although among the more important producing States Illinois, Indiana, Michigan, Missouri, and New Mexico showed notable decrease in percentage. The proportion of machine-mined bituminous coal increased more than 3 per cent, from 51.7 per cent in 1914 to 55 per cent in 1915, Illinois, Kentucky, Missouri, Ohio, Utah, and Virginia showing notable increase in this respect.

For the first time statistics have been collected by the United States Geological Survey to show the quantity of coal recovered from steam-shovel pits. The figures for 1914 were not complete and, although a comparison with 1915 can not be made, it is known that there was a large increase in this new branch of coal mining. The bituminous coal recovered from steam-shovel pits was only 0.6 per cent of the total, but in Indiana, Kansas, and Missouri the coal thus mined represents a notable part of the whole.

Mining conditions in the Pennsylvania anthracite region, where the beds are steeply inclined, faulted, and folded, are quite different from those in the greater part of the bituminous regions, where the beds are usually quite regular and approximately horizontal, and the methods pursued in recovering the coal are therefore quite different in the two areas. For the most part, anthracite is shot from the solid and the practice in that region does not appear to have met with the objections that have developed in the bituminous fields. As shown in the table on page 368, machine mining in the anthracite region has

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not been developed to any great extent, and less than 2 per cent of the total product is recovered in that manner. In fact, the quantity taken from steam-shovel pits is nearly as great as that mined by machines.

Bituminous coal mined by different methods in 1914.

State.	Mined by hand.		Shot off the solid.		Mined by machines.		Not reported.		Total production (net tons).
	Quantity (net tons).	Per cent-age.	Quantity (net tons).	Per cent-age.	Quantity (net tons).	Per cent-age.	Quantity (net tons).	Per cent-age.	
Alabama	5,134,787	32.9	5,498,988	35.3	4,937,222	31.7	22,425	0.1	15,593,422
Arkansas	52,596	2.9	1,431,548	77.9	351,838	19.1	558	.1	1,836,540
Colorado	4,679,245	57.3	945,348	11.6	2,502,558	30.6	43,408	.5	8,170,559
Georgia			166,498	100.0					166,498
Illinois	6,029,477	10.4	18,362,240	31.9	32,640,528	56.7	556,952	1.0	57,589,197
Indiana	1,761,743	10.6	4,968,065	29.9	9,360,683	56.2	550,641	3.3	16,641,132
Iowa	1,449,026	19.5	5,545,842	74.4	308,284	4.1	147,870	2.0	7,451,022
Kansas	1,127,523	16.4	5,275,611	76.9	39,194	.6	418,660	6.1	6,860,988
Kentucky	2,001,410	9.8	2,362,404	11.6	15,731,332	77.2	287,617	1.4	20,382,763
Maryland	3,861,005	93.4	124,966	3.0	110,065	2.7	37,511	.9	4,133,547
Michigan	2,370	.2	281,624	21.9	998,935	77.8	101	.1	1,283,030
Missouri	872,897	22.2	1,834,017	46.6	750,037	19.0	479,029	12.2	3,935,980
Montana	679,822	24.2	895,279	31.9	1,213,051	43.3	17,021	.6	2,805,173
New Mexico	2,521,682	65.0	727,440	18.8	619,472	16.0	9,095	.2	3,877,689
North Dakota	32,215	6.3	193,497	38.2	208,199	41.1	72,774	14.4	506,685
Ohio	1,263,470	6.7	716,666	3.8	16,147,630	85.7	715,349	3.8	18,843,115
Oklahoma	81,227	2.0	2,820,529	70.7	1,053,526	26.4	33,331	.9	3,988,613
Pennsylvania	55,014,192	37.2	2,940,496	2.0	79,657,459	53.8	10,371,147	7.0	147,983,294
Tennessee	2,327,000	39.1	2,234,214	37.6	1,377,964	23.2	4,060	.1	5,943,258
Texas	1,683,644	72.5	612,158	26.3	27,971	1.2			2,323,773
Utah	1,972,029	63.6	183,454	5.9	944,421	30.4	3,132	.1	3,103,036
Virginia	1,439,121	18.0	2,426,501	30.5	4,092,810	51.4	1,103	.1	7,959,535
Washington	1,281,553	41.8	1,443,207	47.1	328,043	10.7	12,017	.4	3,064,820
West Virginia	28,963,391	40.4	371,844	.5	42,263,394	58.9	108,997	.2	71,707,626
Wyoming	1,532,987	23.7	2,204,762	34.0	2,734,151	42.2	3,393	.1	6,475,293
Other States	14,663	19.0	49,944	64.5	500	.6	12,275	15.9	77,382
	125,779,075	29.7	64,617,142	15.3	218,399,287	51.7	[a]13,908,466	3.3	422,703,970

[a] Includes 1,280,946 tons taken out by steam shovels in Illinois, Indiana, Missouri, Kansas, and Oklahoma.

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Bituminous coal mined by different methods in 1915.

State.	Mined by hand.		Shot off the solid.		Mined by machines.		From steam-shovel pits.		Not reported.		Total production (net tons).
	Quantity (net tons).	Percentage.	Quantity (net tons).	Percentage.	Quantity (net tons).	Percentage.	Quantity (net tons).	Percentage.	Quantity (net tons).	Percentage.	
Alabama	4,634,815	31.0	5,001,653	33.5	5,285,123	35.4	(a)	.....	a 6,336	0.1	14,927,937
Arkansas	5,975	.4	1,245,362	75.4	391,373	23.7	.....	.....	8,396	.5	1,652,106
Colorado	4,985,983	57.8	975,346	11.3	2,626,300	30.5	.....	.....	35,351	.4	8,624,980
Georgia	5,655	4.2	128,841	95.8	.....	.....	.....	.....	.....	.....	134,496
Illinois	6,492,893	11.0	15,611,581	26.5	36,011,461	61.2	455,195	0.8	258,446	.5	58,829,576
Indiana	2,189,665	12.9	4,119,406	24.2	9,930,445	58.4	638,220	3.7	128,416	.8	17,006,152
Iowa	1,445,953	19.0	5,668,319	74.4	414,606	5.5	.....	.....	85,265	1.1	7,614,143
Kansas	483,577	7.1	5,492,323	80.5	43,394	.6	780,787	11.4	24,393	.4	6,824,474
Kentucky	1,444,564	6.8	2,273,442	10.6	17,468,502	81.8	.....	.....	175,166	.8	21,361,674
Maryland	3,777,678	90.4	156,957	3.7	224,651	5.4	.....	.....	21,191	.5	4,180,477
Michigan	34,293	3.0	148,694	12.8	973,151	84.2	.....	.....	.....	.....	1,156,138
Missouri	807,677	21.2	1,328,458	34.9	861,957	22.6	655,670	17.2	157,831	4.1	3,811,593
Montana	641,591	23.0	586,611	21.0	1,534,064	55.0	.....	.....	27,489	1.0	2,789,755
New Mexico	3,043,578	79.7	117,456	3.1	644,698	16.9	.....	.....	12,208	.3	3,817,940
North Dakota	24,129	4.6	211,917	40.1	203,775	38.6	.....	.....	88,257	16.7	528,078
Ohio	934,651	4.2	622,236	2.8	20,008,259	89.2	273,263	1.2	596,282	2.6	22,434,691
Oklahoma	118,918	3.2	2,409,284	65.2	1,122,512	30.4	28,484	.8	14,382	.4	3,693,580
Pennsylvania, bituminous	54,502,149	34.5	15,310,937	9.7	87,752,569	55.6	.....	.....	389,482	.2	157,955,137
Tennessee	2,242,321	39.1	1,974,772	34.5	1,507,425	26.3	.....	.....	5,843	.1	5,730,361
Texas	1,596,305	76.4	458,500	22.0	34,103	1.6	.....	.....	.....	.....	2,088,908
Utah	1,471,596	47.3	91,479	2.9	1,540,737	49.6	.....	.....	4,903	.2	3,108,715
Virginia	235,449	2.9	2,753,987	33.91	5,130,527	63.17	.....	.....	2,333	.02	8,122,596
Washington	1,038,017	42.7	1,060,480	44.5	310,598	12.8	.....	.....	.....	.....	2,429,095
West Virginia	30,307,708	39.3	474,694	.6	46,288,657	60.0	.....	.....	113,010	.1	77,184,069
Wyoming	1,436,816	21.9	2,189,097	33.4	2,928,582	44.6	.....	.....	4,533	.1	6,554,028
Other States	22,249	34.9	26,718	41.9	2,272	3.6	.....	.....	12,488	19.6	63,727
Total bituminous	123,924,205	28.0	70,458,550	15.9	243,237,551	55.0	2,831,619	.6	2,172,501	.5	442,624,426
Pennsylvania, anthracite	(b)	.....	(b)	.....	(b)	.....	c 1,121,603	1.3	87,873,458	98.7	88,995,061

a A small quantity of coal taken from one steam-shovel pit included with that not reported by methods.
b This information not requested by the Geological Survey.
c Includes a small quantity of anthracite recovered from culm banks.

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COAL MINED FROM STEAM-SHOVEL PITS.

Remarkable progress has been made in recent years in the use of steam shovels in mining bituminous coal. In the coal fields in some of the Western and Middle Western States there are areas along the outcrop of the flat-lying beds where the cover is insufficient to permit underground mining. For many years sporadic attempts were made to recover this coal by removing the cover with teams and scrapers, but that method is expensive and futile. The modern steam shovel, however, furnishes a means of recovering this coal on a large scale, and, as experience has accumulated, the size of the shovels and of the operations has increased until now steam-shovel mining has ceased to be merely a matter of interest and has become in fact a distinct branch of the coal-mining industry. Ohio, with 7 shovels, and Alabama, in 1915, with 1, entered the list of States that used this method of mining and in all 87 shovels were engaged in this work in the bituminous fields, mainly in Indiana, Illinois, Kansas, and Missouri, and more than 2,800,000 tons of bituminous coal were recovered from the steam-shovel pits. More than half of this output came from a comparatively small area in southeastern Kansas and adjacent territory in Missouri, where this method of mining bituminous coal was first commercially successful. Some of the shovels weigh more than 300 tons and have dipper capacity of more than 7 cubic yards. Overburden to a depth of 25 or more feet is removed to uncover from 3 to 4½ feet of coal. That coal can be mined with steam shovels more cheaply than by underground methods is indicated by the fact that the average daily output per employee in the strip-pit operations is twice as great as the average for the respective States. In other words, the labor cost is about one-half as great. Strip-pit coal does not, however (except locally), bring so high a price in the market as other coal from the same bed mined from under deeper cover. The average value per ton for the pit coal from Illinois was 10 cents and from Indiana was 20 cents less than the average for the State. The difference in Kansas was 8 cents; Missouri, 7 cents; and Ohio, 17 cents. The Oklahoma pit coal averaged 7 cents higher than the output of the State.

In the anthracite region of Pennsylvania 57 shovels were used for stripping the cover from the coal, and to a small extent for recovering culm from the old banks. More than a million tons of anthracite were mined in this manner in 1915, and the operations of these pits in the anthracite region have been developed through many years to a high state of engineering efficiency. In a recent paper before the American Institute of Mining Engineers, Mr. J. B. Warriner states that the earliest mining on a commercial scale in the anthracite region was a stripping operation. This was the famous Quarry mine at Summit Hill, and "cattle and scrapers" were used to remove the dirt and coal. This work appears to have been done prior to 1821. Mr. Warriner states that the first steam shovel was used in the anthracite region in 1881. It weighed 30 to 35 tons and had a dipper capacity of 1 cubic yard. Even to-day the shovels used there are smaller than those in the bituminous regions, but this is because of the different nature of the work to be performed and the conditions under which the beds occur.

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The statistics of steam-shovel operations are somewhat meager. A summary of those collected by the United States Geological Survey for 1915 is shown in the following table. Data regarding the depth of cover and yardage handled were published in the report of this series for 1914.

Coal recovered from steam-shovel strip pits in 1915.

State.	Number of shovels.	Quantity of coal mined (net tons).	Average tonnage per man.		Average value per ton.
			Per day.	Per year.	
Alabama	1	(a)			
Illinois	10	455,195	8.7	1,979	$1.00
Indiana	22	638,220	8.3	1,474	.90
Kansas	23	780,787	5.3	1,169	1.58
Missouri	20	655,670	4.4	870	1.66
Ohio	7	273,263	7.0	1,763	.91
Oklahoma	4	28,484	4.3	274	2.08
Total bituminous (except Alabama)	87	2,831,619	6.0	1,208	1.29
Pennsylvania, anthracite	57	1,121,603			
Grand total (except Alabama)	144	3,953,222			

a Only one steam shovel was in use in Alabama, and the extent of its operations can not be revealed.

COAL-WASHING OPERATIONS.

Coal is washed to reduce impurities, ash and sulphur, and thus to improve the quality of the product either for the market or for making coke. From the time the coal is broken down in the mine, every effort is made to eliminate the refuse. Miners are penalized for loading out dirt with the coal; bone and slate are removed on the picking tables in the tipples; and those alive to the best interests of the property never miss an opportunity to reject refuse found in mine or railroad cars. The motto of the progressive companies is "a clean product."

Not all coal can be cleaned by hand picking. Some coal beds or parts of beds have layers or benches of slate and bone or contain more than the allowable quantity of sulphur in the form of iron pyrite so thoroughly mixed with the coal that crushing is necessary to free the coal from the refuse. For such coal washing is resorted to and the coal, being lighter than the refuse, is separated by currents of water. Coal is also cleaned in the dry state, and the product of one large company in Illinois is so treated, the results being included in the statistics of washed coal. A large part of the washed coal is slack used in the manufacture of coke, notably in Pennsylvania and West Virginia. In the statement of the total production of coal in the United States the refuse is deducted and only the cleaned coal is considered as the marketed or commercial product.

Alabama leads in quantity of coal washed, more than one-third of the total quantity so treated in 1915 being from that State. The total quantity of cleaned coal from the Alabama washeries in 1915 was 7,920,122 net tons, of which about 57 per cent was used in the manufacture of coke. Pennsylvania was second in the quantity of coal sent to the washeries—4,317,338 tons of cleaned coal, practically all of which was used in the manufacture of coke. In Illinois

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3,323,321 tons were sent to the washeries, and the quantity of washed coal obtained was 2,891,001 tons. A very small portion of this was mixed with West Virginia coal and was used in the retort ovens; the remainder was sized coal, used principally for household fuel. In the State of Washington 1,304,617 tons were sent to the washeries, and the cleaned coal obtained was 981,817 tons, of which about 21 per cent was used in the manufacture of coke and the remainder went into the regular market.

In the anthracite region of Pennsylvania considerable quantities of usable coal have for many years been recovered by washeries from old culm banks. This item amounted in 1915 to 3,359,214 gross tons, or 3,762,320 net tons, as compared with 2,525,008 gross tons, or 2,828,009 net tons in 1914. The quantity of coal recovered by the anthracite washeries is not included in the following table, which shows the quantity of bituminous coal washed at the mines in 1915:

Bituminous coal washed at the mines in 1915.

State.	Coal washed (net tons).	Cleaned coal (net tons).	Refuse (net tons).	Percentage of cleaned coal to total State output.
Alabama	8,734,475	7,920,122	814,353	53.0
Colorado	353,792	293,201	60,591	3.5
Georgia	99,895	78,906	20,899	56.0
Illinois	3,323,321	2,891,001	432,320	5.0
Indiana	102,527	87,832	14,695	.5
Kansas, Michigan, Missouri, New Mexico, Oklahoma, and Texas	944,967	768,940	176,027	3.6
Kentucky	283,613	249,923	33,690	1.2
Montana and Oregon	647,783	603,496	44,287	22.0
Ohio	221,341	195,091	26,250	.9
Pennsylvania	4,740,673	4,317,338	423,335	2.5
Tennessee	560,022	495,907	64,115	2.0
Virginia	194,179	178,525	15,654	2.0
Washington	1,304,617	981,817	322,800	4.0
West Virginia	1,960,831	1,811,538	149,293	2.3
	23,472,036	20,873,727	2,598,309	5.0

ACCIDENTS.

The fatal-accident statistics for 1915 presented herewith show a most creditable record. The total number of fatal accidents in 1915, as reported by the Bureau of Mines, was the lowest since 1907; the death rate per 1,000 employed was the lowest since 1898; and the production of coal for each life lost was the greatest on record. The total number of deaths in 1915 was 2,266, compared with 2,454 in 1914 and 2,785 in 1913; the death rate per 1,000 employees was 3.1 in 1915, 3.22 in 1914, and 3.73 in 1913, and the production in tons per death was 234,607 in 1915, against 209,261 in 1914 and 204,685 in 1913.

The best record for the year was made by Texas, in which State more than 2,000,000 tons of coal were mined with the loss of but one life. There were no fatal accidents in 1915 in the coal mines of Alaska, California, Idaho, Nevada, Georgia, Oregon, and South Dakota, all States with small outputs of coal, their combined output having been less than 200,000 tons. Among the States of large production, Illinois showed the best record, with a death rate of 1.8 per

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1,000 men, and more than 400,000 tons for each fatal accident. The record of Maryland was about the same as that of Illinois. Three explosions in Washington and one in West Virginia increased the number of deaths in those States, whose records are among the worst for the year 1915.

Fatal accidents in coal mines in the United States in 1915.

State.	Production (net tons).	Number of men employed.	Number of men killed.[a]					Coal produced per man killed (net tons)
			Underground.	In shaft.	On the surface.	Total.	Per 1,000 employed.	
Alabama	14,927,937	22,591	60	1	2	63	2.8	236,951
Alaska	1,400					0		
Arkansas	1,652,106	3,751	6		2	8	2.1	206,513
California, Idaho, and Nevada	12,503	36				0		
Colorado	8,624,980	12,372	59	1	3	63	5.1	136,904
Georgia	134,496	368				0		
Illinois	58,829,576	75,610	126	5	5	136	1.8	432,570
Indiana	17,006,152	22,777	41	2	3	46	2.0	369,699
Iowa	7,614,143	15,549	30	2	2	34	2.2	223,945
Kansas	6,824,474	13,260	22	1	1	24	1.8	284,353
Kentucky	21,361,674	27,960	59	2	3	64	2.3	333,776
Maryland	4,180,477	5,664	9		1	10	1.8	418,048
Michigan	1,156,138	2,569	5	1	1	7	2.7	165,163
Missouri	3,811,593	9,173	16	1		17	1.9	224,211
Montana	2,789,755	3,158	11	1	1	13	4.1	214,597
New Mexico	3,817,940	4,205	19			19	4.5	200,944
North Dakota	528,078	590	1			1	1.7	528,078
Ohio	22,434,991	40,053	64	1		65	1.6	345,149
Oklahoma	3,608,580	8,457	16	1	5	22	2.6	167,890
Oregon	39,231	151				0		
Pennsylvania (anthracite)	88,995,061	176,552	516	10	60	586	3.3	151,869
Pennsylvania (bituminous)	157,955,137	174,593	400	8	30	438	2.5	360,628
South Dakota	10,598	35				0		
Tennessee	5,730,361	8,948	25			25	2.8	229,214
Texas	2,088,908	5,087		1		1	.2	2,088,908
Utah	3,108,715	3,564	10		1	11	3.1	282,610
Virginia	8,122,596	8,959	46		2	48	5.4	169,221
Washington	2,429,095	4,850	42		3	45	9.3	53,980
West Virginia	77,184,069	75,882	460	2	32	494	6.5	156,244
Wyoming	6,554,028	7,244	23		3	26	3.6	252,078
	531,619,487	734,008	2,066	40	160	2,266	3.1	234,607

[a] Accident statistics from reports of Bureau of Mines.

VALUES PER TON.

It should be emphasized that the value per ton given in this report is the average obtained by dividing the total value by the total tonnage. The operators are requested in the schedules of inquiry sent out by the Geological Survey to give the total selling value at the mine for their entire output, including the fuel used at the mines for steam and heat and excluding only the slack wasted. The coal used at the mine, that coked by the producing company, and that used in some other industry by the company operating the mine, an appreciable proportion of the whole, is never sold, and the value placed upon it is either an estimate or the figure at which it is carried on the books, either of which is supposedly based upon what the product would have brought if sold or what fuel for the respective purpose would have cost if its purchase had been necessary. In other words, the values given represent returns to the operators for coal sold, plus estimated exchange value of that not sold.

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These figures do not necessarily show prices or even average prices of coal at the mines. Depending on market conditions, lump coal may be bringing a higher price than mine-run, or slack may range the highest. The coal produced in a single day is probably disposed of at as many different rates per ton as there were sizes made. Furthermore, the same size may be invoiced at different prices at the same mine at any one time. A large part of the railroad fuel and of the so-called commercial coal is sold on contracts usually of a year's duration, but as producers seldom contract for their entire output, more or less "free" coal is always available. As a usual thing the operator obtains more for his free coal than for his contract. It can therefore be seen that prices vary greatly throughout the year and that an average of these prices would not represent the character of the year's business.

The bituminous-coal operator does not as a general rule ascertain carefully the total cost of producing his coal and thus establish a price below which he will not sell, but he usually takes what he can get for his product, probably believing that in dull times it is better to accept a loss in sales than to close the mine, and hoping that he can retrieve his fortunes when conditions are more prosperous. The contract prices for coal are governed to a considerable extent by the optimism, or the reverse, of the mine operator. During dull times the prices are low, as there is more coal available than is needed, and these prices are somewhat slow in responding to the upward trend when business improves, either because by chance the improvement begins after the period of fixing contract prices or because the change in the tide is not realized or appreciated by the coal trade until it is well on its upward way.

The changes in average value over a period of years and their relation to production are shown graphically in figure 18.

Beginning in 1898, when the average value of bituminous coal was at the lowest point of which there is a record, it will be noted that there were three high points in the curve of production, 1903, 1907, and 1913, followed by three low points, 1904, 1908, and 1914, the decrease in 1911 being considered but a minor deflection in the general upward trend. As has been shown earlier in the report, these rises and falls in production of coal correspond to the cycles of industrial activity and do not lag, to an appreciable extent, behind the corresponding movements of the industries on which coal depends for its demand. For the same period the same cycles appear in the curve of average values, but with the difference that although the maxima occur in the same years the minima do not, the low points in the average value curve occurring each time a year later than in the production curve and therefore in years of increasing prosperity and rising rate of production. As this is being written, it is evident that the production of coal in 1916 will exceed that in 1915 and probably also that in 1913. Were no other evidence at hand it would be warrantable, from a consideration of past years, to expect greater average returns for this coal than were obtained in 1915. In other words, $1.13 per ton for bituminous coal and lignite in 1915 is a low point in the curve.

It will be noted also that each succeeding cycle represents a higher range of values, due of course to the rising cost of production. The lower limit will never be below the cost of production of a sufficient

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quantity of the coal to affect seriously the supply on the market. The very high average for 1903 was abnormal, and due to the great shortage of fuel following the disastrous labor strike in the Pennsylvania anthracite field in 1902.

Figure 18 also shows the relation of the production of Pennsylvania anthracite to its average value at the mines. It is well to repeat that the average value here given is obtained by dividing total value by total output. There is a wide variation in the prices for the different sizes of anthracite (see p. 417), and the average value here used is

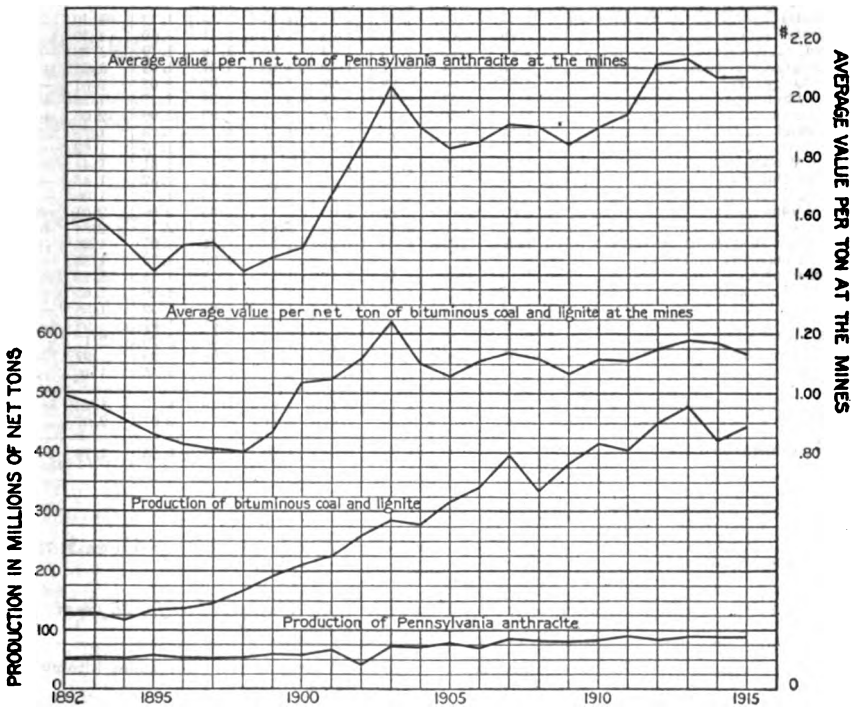

FIGURE 18.—Average value per ton at the mines and annual production of Pennsylvania anthracite and of bituminous coal and lignite in the United States, 1892–1915.

affected not only by changes in price during the year, but also by varying quantities of the different sizes sold.

Anthracite is a fuel of domestic use and does not enter into the industries like bituminous coal, and therefore does not respond, save in a general way, to the influences affecting trade. The rate of production is not subject to the variations that attend bituminous coal, but the average value shows much the same tendency noted with soft coal, although the range is much greater.

The average values for each State from 1908 to 1915, and the averages for anthracite and bituminous coal at the mines for the United States from 1880 to date, are shown in the following tables.

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Average value per net ton of coal at the mines since 1908.

State.	1908	1909	1910	1911	1912	1913	1914	1915	Advance or decline in 1915.
Alabama	$1.26	$1.19	$1.26	$1.27	$1.29	$1.31	$1.34	$1.28	−$0.06
Arkansas	1.68	1.48	1.56	1.61	1.71	1.76	1.72	1.79	+ .07
California	[a]3.19	2.21	[a]2.74	[a]2.00	[a]2.33	[a]3.54	[b]2.85	[a b]2.54	− .31
Colorado	1.41	1.33	1.42	1.45	1.49	1.52	1.66	1.58	− .08
Georgia	1.38	1.41	1.46	[c]1.49	[c]1.49	1.41	[d]1.44	1.72	+ .01
Idaho	4.02	4.27	3.92	[e]2.68	[e]3.14	2.43	(b)	(b)	.....
Illinois	1.05	1.05	1.14	1.11	1.17	1.14	1.12	1.10	− .02
Indiana	1.06	1.02	1.13	1.08	1.14	1.11	1.10	1.10	.....
Iowa	1.63	1.65	1.75	1.73	1.80	1.79	1.79	1.78	− .01
Kansas	1.49	1.44	1.61	1.53	1.62	1.67	1.64	1.66	+ .02
Kentucky	1.01	.94	.99	.99	1.02	1.05	1.02	1.01	− .01
Maryland	1.17	1.11	1.12	1.11	1.18	1.24	1.27	1.28	+ .01
Michigan	1.81	1.79	1.91	1.78	1.99	1.99	1.99	2.05	+ .06
Missouri	1.64	1.65	1.79	1.72	1.76	1.73	1.73	1.73	.....
Montana	1.96	1.97	1.82	1.79	1.82	1.74	1.75	1.62	− .13
New Mexico	1.37	1.29	1.39	1.44	1.42	1.46	1.61	1.44	− .17
North Dakota	1.63	1.56	1.49	1.43	1.53	1.52	1.53	1.45	− .07
Ohio	1.06	.99	1.05	1.03	1.07	1.10	1.13	1.08	− .05
Oklahoma	2.03	2.00	2.22	2.05	2.14	2.05	2.06	2.01	− .05
Oregon	2.74	2.69	3.48	2.32	2.60	2.53	2.78	2.84	+ .06
Pennsylvania, bituminous	1.01	.94	1.02	1.01	1.05	1.11	1.07	1.06	− .01
South Dakota	.....	.....	.....	.....	.....	1.96	1.73	1.55	− .18
Tennessee	1.15	1.09	1.11	1.12	1.14	1.14	1.14	1.13	− .01
Texas	1.80	1.72	1.67	1.66	1.67	1.77	1.69	1.65	− .04
Utah	1.69	1.66	1.68	1.69	1.67	1.65	1.59	1.58	− .01
Virginia	.91	.89	.90	.91	.96	1.01	1.01	.98	− .03
Washington	2.21	2.54	2.50	2.29	2.39	2.38	2.20	2.17	− .03
West Virginia	.95	.86	.92	.90	.94	1.01	.99	.97	− .02
Wyoming	1.62	1.55	1.55	1.56	1.58	1.56	1.55	1.46	− .09
Total bituminous	1.12	1.07	1.12	1.11	1.15	1.18	1.17	1.13	− .04
Pennsylvania, anthracite	1.90	1.84	1.90	1.94	2.11	2.13	2.07	2.07	.....
General average	1.28	1.20	1.25	1.26	1.30	1.33	1.33	1.29	− .04

[a] Includes Alaska.
[b] California includes Idaho and Nevada.
[c] Includes North Carolina.
[d] Average for total output including refuse from washery. The average excluding refuse was $1.71.
[e] Includes Nevada.

Average value per net ton of coal at the mines in the United States for 36 years.

Year.	Anthracite.	Bituminous.	Year.	Anthracite.	Bituminous.
1880	$1.47	$1.25	1898	$1.41	$0.80
1881	2.01	1.12	1899	1.46	.87
1882	2.01	1.12	1900	1.49	1.04
1883	2.01	1.07	1901	1.67	1.05
1884	1.79	.94	1902	1.84	1.12
1885	2.00	1.13	1903	2.04	1.24
1886	1.95	1.05	1904	1.90	1.10
1887	2.01	1.11	1905	1.83	1.06
1888	1.91	1.00	1906	1.85	1.11
1889	1.44	.99	1907	1.91	1.14
1890	1.43	.99	1908	1.90	1.12
1891	1.46	.99	1909	1.84	1.07
1892	1.57	.99	1910	1.90	1.12
1893	1.59	.96	1911	1.94	1.11
1894	1.51	.91	1912	2.11	1.15
1895	1.41	.86	1913	2.13	1.18
1896	1.50	.83	1914	2.07	1.17
1897	1.51	.81	1915	2.07	1.13

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PRODUCTION OF COAL BY STATES.

In the preceding sections of this report the statistics covering the production of coal in the United States have been presented with the States as units. Both the statistics and the coal industry have been discussed mainly from the standpoint of the United States as a whole. It will be realized, however, that many of the inferences drawn from the figures in the aggregate do not apply with equal force when smaller units, such as individual States, are considered, and of course this is all the truer of the still smaller units, the counties constituting the States. In the following pages a brief review of the trade in each State is given in connection with detailed statistics of production by counties. For data regarding labor, strikes, accidents, use of mining machines and steam shovels, and coal-washing operations the reader is referred to the preceding pages.

ALABAMA.

Total production in 1915, 14,927,937 net tons; spot value, $19,066,043. This represents a decrease of 665,485 tons, or 4 per cent, in quantity and of $1,783,876, or 9 per cent, in value compared with 1914. During the early part of the year many of the Alabama operators, less hopeful than the others, contracted for the sale of their output at lower prices than previously, with the result that the average value for the year decreased from $1.34 per ton in 1914 to $1.28 in 1915. The number of men employed decreased from 24,042 in 1914 to 22,591 in 1915 and the average number of days worked per man from 226 to 223. There was, however, no shortage of labor during the year.

The demand for Alabama coal was very light during the first half of 1915 and many mines were shut down. In August, however, marked industrial activity began, and the general resumption of operations by practically all the Alabama iron furnaces was a large factor in increasing the rate of production of coal toward the end of the year. Railroad and industrial activities were nevertheless below normal throughout the year, and the total output of coal was less than in any other period since 1909. In ordinary times Alabama supplies a large quantity of coal for steamship bunkers at Pensacola, Mobile, Gulfport, and New Orleans; but since the European war began there has been little call for coal for that purpose at those ports. The development of water power on a large scale in Alabama has also cut off the market for a large quantity of coal. The opening of Warrior River to navigation was expected to offer an outlet for large quantities of coal to New Orleans and Mobile ports, but in 1915 there was no demand from those sources and a comparatively small quantity of Alabama coal found markets over that waterway.

The statistics of the production of coal in Alabama in 1914 and 1915 are shown in the following tables:

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Coal produced in Alabama in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Bibb	1,565,660	9,180	100,006	.....	1,674,846	$2,576,057	$1.54	2,986	242
Blount	147,640	1,300	1,444	.....	150,384	188,235	1.25	348	163
Etowah	153,402	1,293	2,214	.....	156,909	222,239	1.42	279	241
Jefferson	6,515,079	46,527	292,071	1,082,468	7,936,145	10,486,552	1.32	11,343	236
St. Clair	726,132	1,816	24,640	.....	752,588	978,196	1.30	896	229
Shelby	467,456	3,916	27,542	.....	498,914	927,442	1.86	936	239
Tuscaloosa	428,387	13,355	59,562	357,595	858,899	1,177,473	1.37	1,491	226
Walker	3,037,567	51,284	112,704	248,630	3,450,185	4,124,363	1.20	5,416	199
Winston	31,035	525	58	.....	31,618	46,787	1.48	101	248
Other counties [a]	73,496	1,704	5,841	.....	81,041	119,496	1.47	246	187
Small mines	.....	1,893	.....	.....	1,893	3,079	1.63	.....	.....
	13,145,854	132,793	626,082	1,688,693	15,593,422	20,849,919	1.34	24,042	226

[a] Cullman, Jackson, and Marion counties.

1915.

Bibb	1,420,639	8,359	105,536	.....	1,534,534	$2,093,131	$1.36	2,623	235
Blount	163,019	1,021	1,700	.....	165,739	226,716	1.37	368	189
Etowah	173,583	1,974	1,811	.....	177,368	259,332	1.46	325	239
Jefferson	5,884,992	329,456	197,806	1,167,249	7,579,503	9,658,536	1.27	10,129	235
Marion	62,653	1,275	4,962	.....	68,890	101,318	1.47	199	163
St. Clair	754,569	2,959	16,530	.....	774,058	946,446	1.22	786	252
Shelby	550,594	3,290	35,528	.....	589,412	989,580	1.68	1,058	227
Tuscaloosa	296,627	9,545	71,277	408,137	787,586	963,910	1.22	1,334	209
Walker	2,886,594	29,926	99,950	205,486	3,221,955	3,784,424	1.17	5,669	197
Winston	26,217	370	40	.....	26,627	38,919	1.46	80	191
Small mines [a]	1,000	1,065	200	.....	2,265	3,431	1.51	20	12
	12,222,486	389,239	535,340	1,780,872	14,927,937	19,066,043	1.28	22,591	223

[a] Includes Jackson County.

In the following table comparative statistics are given covering five years' annual production of coal in Alabama, by counties. The three counties of largest production, Bibb, Jefferson, and Walker, were all below the average for the 5-year period. In fact, both Bibb and Jefferson in 1915 had the lowest output in five years. Shelby County has shown consistent gains each year, and 4 counties out of 11 recorded increase in 1915.

Coal produced in Alabama, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Bibb	1,633,197	1,781,335	1,911,026	1,674,846	1,534,534	− 140,312
Blount	82,266	146,342	178,968	150,384	165,739	+ 15,355
Cullman, Jackson, and Marion	(a)	131,505	128,615	81,041	[b] 70,290	− 10,751
Etowah	255,360	171,308	137,792	156,909	177,368	+ 20,459
Jefferson	7,776,390	8,174,849	9,028,834	7,936,145	7,579,502	− 356,642
St. Clair	529,211	749,753	890,379	752,588	774,058	+ 21,470
Shelby	463,089	496,949	497,569	498,914	589,412	+ 90,498
Tuscaloosa	1,031,558	880,967	917,305	858,899	787,586	− 71,313
Walker	3,103,595	3,547,962	3,967,263	3,450,185	3,221,955	− 228,230
Winston	16,424	18,730	24,951	31,618	26,627	− 4,991
Small mines	a 129,731	900	880	1,893	865	− 1,028
Total	15,021,421	16,100,600	17,678,522	15,593,422	14,927,937	− 665,485
Total value	$19,079,949	$20,829,252	$23,083,734	$20,849,919	$19,066,043	−$1,783,876

[a] Small mines include Cullman, Jackson, and Marion counties.
[b] No production in Cullman County.

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ALASKA.[1]

There were no important developments in the coal or oil fields of Alaska in 1915. Under the new leasing law a number of permits were granted to mine coal in tracts of 10 acres or less, and some lignitic coal was mined at a number of localities to supply a local market. The largest of these operations was at the Bluff Point mine, on the north side of Kachemak Bay, an eastern indentation of Cook Inlet. This property was operated for most of the year, and its product was marketed at Seward, Anchorage, and other places near by. Smaller operations were carried on to supply coal to placer-mining plants in the Yentna and Fairhaven districts and probably at other localities. It is estimated that the total production was about 1,400 tons, valued at $3,300.

The subjoined table shows the coal consumption of Alasks, including both imports and local production, since 1899. Most of the coal thus far mined is lignite. There was, however, in 1906, a small production of bituminous coal from the seaward end of the Bering River field. The table does not include 855 tons of coal mined in the Bering River field in 1912 and 1,100 tons mined in the Matanuska field in 1913 for the United States Navy. Most of the foreign coal shipped to Alaska is bituminous, only a little being anthracite. In 1915 there were 1,771 tons of foreign anthracite imported into Alaska.

Of the coal shipped in 1915 to Alaska,[2] 4,409 tons went to Nome and represented the total consumption of coal in the Seward Peninsula, except for a little lignite mined on Chicago Creek. The small consumption is due to the fact that most of the dredges, which are the largest consumers of fuel, use either crude oil or gasoline. About 50 tons of coal are shipped to St. Michael, which includes the local consumption and the blacksmith coal for the Yukon camps.

The passage of the coal-leasing act has again attracted attention to the development of the Alaskan fields. As a consequence some systematic investigations were made by those who contemplated application for leases. This is notably true of the Matanuska field, which will soon be rendered accessible by the Government railroad now under construction.

[1] Brooks, A. H., The Alaskan mining industry in 1915: U. S. Geol. Survey Bull. 642, p. 30, 1916 (Bull. 642-A).

[2] Data received through the courtesy of the deputy collector of customs at Nome

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Coal consumed in Alaska, 1899–1915, in net tons.

Year.	Imported from States, chiefly from Washington.		Produced in Alaska, chiefly subbituminous and lignite.[a]	Total domestic, chiefly from Washington.[a]	Total foreign coal, chiefly bituminous from British Columbia.[b]	Total coal consumed.
	Bituminous.	Anthracite.				
1899	[c] 10,000	.....	[c] 1,200	11,200	50,120	61,320
1900	15,048	.....	[c] 1,200	16,248	56,623	72,871
1901	[c] 24,000	.....	[c] 1,300	25,300	77,674	102,974
1902	[c] 40,000	.....	2,212	42,212	68,363	110,575
1903	64,625	1	1,447	66,073	60,605	126,678
1904	36,689	.....	1,694	38,383	76,815	115,198
1905	67,707	6	3,774	71,487	72,567	144,054
1906	68,960	533	5,541	75,034	47,590	122,624
1907	45,130	1,116	10,139	56,385	88,596	144,981
1908	23,402	491	3,107	27,000	72,831	99,831
1909	33,112	.....	2,800	35,912	74,316	110,228
1910	32,138	.....	1,000	33,138	73,904	107,042
1911	32,255	.....	900	33,155	88,573	121,728
1912	27,767	.....	355	28,122	59,804	87,926
1913	61,666	.....	2,300	63,966	60,600	124,566
1914	37,062	.....	.....	37,062	21,882	58,944
1915	41,365	.....	[c] 1,400	42,765	36,878	79,643
Total	660,926	2,147	40,369	703,442	1,087,741	1,791,183

[a] By calendar years. [b] By fiscal years ending June 30. [c] Estimated.

ARKANSAS.

A large part of the coal produced in Arkansas is used for locomotive fuel. Retrenchments by the railroad companies in operating expenses and competition with fuel oil from near-by fields have seriously interfered with the output in the State. The production in 1915 was 1,652,106 net tons, valued at $2,950,456, compared with 1,836,540 tons, valued at $3,158,168, in 1914, and with more than 2,000,000 tons, valued at nearly $4,000,000, in 1913.

Sebastian County, which produces about 70 per cent of the total output of the State, decreased more than a quarter of a million tons, whereas all other counties recorded increase. The output of coal in Sebastian County in 1915 was 1,153,494 tons, the lowest since 1900 and 720,000 tons less than in 1907, the record year in the field. The advance in the price of fuel oil late in 1915, if continued, will probably have the effect of increasing the use of Arkansas coal and assist that State to recover to some extent the markets that have been lost in late years.

There were 3,751 men employed in and about the coal mines of Arkansas in 1915, and they worked for an average of 149 days, compared with 4,339 men for 143 days in 1914. No labor shortage was reported in the Arkansas fields in 1915.

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Coal produced in Arkansas in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Franklin	158,722	1,550	8,474	168,746	$294,652	$1.75	447	147
Johnson	140,133	1,804	6,908	148,845	330,256	2.22	639	102
Logan	6,030	766	376	7,172	13,974	1.95	26	212
Sebastian	1,353,443	3,472	66,287	1,423,202	2,342,563	1.65	2,897	150
Other counties[a]	77,541	5,485	5,021	88,047	175,485	1.99	330	151
Small mines	.....	528	.....	528	1,238	2.34	.....	.....
	1,735,869	13,605	87,066	1,836,540	3,158,168	1.72	4,339	143

[a] Ouachita, Pope, Scott, and Washington.

1915.

Franklin	178,955	4,834	6,448	190,237	$333,551	$1.75	349	154
Johnson	161,899	6,775	7,783	176,457	418,239	2.37	691	108
Logan	28,601	250	654	29,505	54,984	1.86	138	111
Sebastian	1,087,995	22,366	43,133	1,153,494	1,838,798	1.59	2,284	154
Other counties[a]	86,221	3,139	4,157	93,517	280,171	3.06	289	221
Small mines	.....	8,896	.....	8,896	18,723	2.10	.....	.....
	1,543,671	46,260	62,175	1,652,106	2,950,456	1.79	3,751	149

[a] Pope, Scott, and Washington counties.

Coal produced in Arkansas, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Franklin	421,591	373,314	346,682	168,746	190,237	+ 21,491
Johnson	137,081	192,326	166,208	148,845	176,457	+ 27,612
Logan	11,974	15,272	(a)	7,172	29,505	+ 22,333
Pope, Scott, and Washington	[b] 51,611	[c] 65,416	[c d] 85,136	[e] 88,047	93,517	+ 5,470
Sebastian	1,484,532	1,454,128	1,635,379	1,423,202	1,153,494	− 269,708
Small mines	(a)	363	702	528	8,896	+ 8,368
Total	2,106,789	2,100,819	2,234,107	1,836,540	1,652,106	− 184,434
Total value	$3,396,849	$3,582,789	$3,923,701	$3,158,168	$2,950,456	−$207,712

[a] Included with Pope and other counties.
[b] Includes small mines.
[c] No production in Scott County.
[d] Includes Logan County.
[e] Includes Ouachita County.

CALIFORNIA.

As there were only two mines in California from which an output of coal was reported in 1915 and only one mine in each of the States of Idaho and Nevada, the total production in the three States in 1915 is given combined in order not to disclose individual output. This total production amounted to 12,503 net tons, valued at $32,054.

The statistics of the production of coal in California in 1910 to 1913, and in California, Idaho, and Nevada in 1914 and 1915, are shown in the following table:

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Coal produced in California, 1910–1915, and in California, Idaho, and Nevada in 1914 and 1915.

Year.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
1910	6,679	3,985	500	11,164	$18,396	$1.64	14	192
1911	4,981	5,266	500	10,747	16,097	1.50	45	264
1912	3,748	3,630	3,600	10,978	23,601	2.15	52	184
1913	14,864	1,808	8,167	24,839	84,073	3.38	35	332
1914[a]	4,200	9,174	600	13,974	39,821	2.85	43	291
1915[a]	2,488	9,715	300	12,503	32,054	2.56	36	285

[a] Includes Idaho and Nevada.

COLORADO.

Total production in 1915, 8,624,980 net tons; spot value, $13,599,264.

Coal mining in Colorado quickly recovered from the effects of the strike of 1913 and 1914, and the production in 1915 showed an increase of 454,421 tons, or 5.6 per cent, in quantity, compared with 1914, although the total value in the two years was practically the same. The increase is largely accounted for by the resumption of the operation of mines (notably those in Fremont County) that were shut down in 1914 by reason of the strike. The greatest increase was in Fremont County, but the output of El Paso, Garfield, Gunnison, Las Animas, and Routt counties also increased. A good quality of coal is being mined in Routt County, in the northwestern part of the State, and several new developments of considerable size are shipping their product out over the line of the Moffat road, recently completed to Craig, on Yampa River. This coal is being marketed as far east as Omaha and it is reported that it has been found to be a good domestic coal.

There were no labor disturbances in the Colorado coal fields in 1915 and the car supply was plentiful. That there was not a greater increase is attributed to the mild winter weather and to the general quietude of business during the early months of the year.

The number of men employed increased from 10,098 in 1914 to 12,372 in 1915, but the average days worked decreased from 244 to 194. The average daily output per man was 3.6 tons and the average yearly output 697 tons, compared with 3.3 and 809 tons, respectively, in 1914.

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Coal produced in Colorado in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Archuleta and Montezuma	.....	3,775	.....	.....	3,775	$8,858	$2.35	9	157
Boulder	939,957	12,109	48,524	.....	1,000,590	1,596,305	1.60	1,203	213
Delta	77,552	8,409	900	.....	86,861	130,273	1.50	102	192
El Paso	150,435	121,535	8,607	.....	280,577	438,092	1.56	349	249
Fremont	148,325	14,631	6,315	.....	169,271	431,403	2.55	255	262
Garfield	101,546	2,136	9,160	.....	112,842	188,130	1.67	135	249
Gunnison	379,923	2,596	19,526	.....	402,045	632,945	1.57	531	208
Huerfano	1,661,063	9,912	53,290	.....	1,724,265	3,200,729	1.86	2,244	259
Jackson and Jefferson	172,424	2,923	12,733	.....	188,080	255,845	1.36	260	185
La Plata	100,189	16,804	1,348	13,976	132,317	211,555	1.60	185	202
Las Animas	1,426,121	40,321	87,525	1,139,321	2,693,288	4,151,333	1.54	3,318	269
Mesa	122,997	34,797	6,100	.....	163,894	250,980	1.53	196	221
Pitkin and Rio Blanco	57,474	1,628	5,823	179	65,104	99,128	1.52	67	298
Routt	636,650	7,804	21,930	.....	666,384	1,298,428	1.95	681	246
Weld	428,134	29,236	18,364	.....	475,734	697,682	1.47	563	180
Small mines	.....	5,532	.....	.....	5,532	10,032	1.81	.....	.....
	6,402,790	314,148	300,145	1,153,476	8,170,559	13,601,718	1.66	10,098	244

1915.

Archuleta and Montezuma	1,775	600	.....	.....	2,375	$6,038	$2.54	7	196
Boulder	895,299	16,758	34,831	.....	946,888	1,483,840	1.57	1,080	183
Delta	61,472	7,281	300	.....	69,053	106,980	1.55	91	132
El Paso	179,300	110,390	10,193	.....	299,883	442,161	1.47	312	222
Fremont	444,962	18,336	9,986	.....	473,284	986,797	2.08	974	148
Garfield	126,609	3,809	8,975	.....	139,393	211,305	1.52	165	221
Gunnison	413,057	2,587	22,517	1,242	439,403	694,236	1.58	563	166
Huerfano	1,605,870	19,683	56,782	.....	1,682,335	2,786,069	1.66	2,857	196
Jackson and Jefferson	139,604	2,918	9,976	.....	152,498	207,306	1.36	252	146
La Plata	84,008	18,292	1,398	13,804	117,502	206,109	1.75	151	201
Las Animas	1,745,838	24,341	83,368	1,000,300	2,853,847	4,037,592	1.41	4,030	212
Mesa	72,142	26,185	3,000	.....	101,327	145,461	1.44	155	153
Pitkin and Rio Blanco	45,294	1,506	5,343	.....	52,143	79,838	1.53	82	159
Routt	823,560	5,425	23,330	.....	852,315	1,569,174	1.84	1,089	220
Weld	385,030	22,899	24,572	.....	432,501	618,296	1.43	564	157
Small mines	.....	10,233	.....	.....	10,233	18,062	1.77	.....	.....
	7,023,820	291,243	294,571	1,015,346	8,624,980	13,599,264	1.58	12,372	194

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Coal produced in Colorado, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Archuleta and Montezuma	(a)	2,500	(b)	3,775	2,375	− 1,400
Boulder	954,752	1,054,925	902,918	1,000,590	946,888	− 53,702
Delta	71,399	75,043	86,464	86,861	69,053	− 17,808
El Paso	332,155	334,904	326,899	280,577	299,883	+ 19,306
Fremont	661,240	738,833	535,778	169,271	473,284	+304,013
Garfield	165,908	185,452	158,662	112,842	139,393	+ 26,551
Gunnison	575,648	557,685	472,753	402,045	439,403	+ 37,358
Huerfano	1,786,654	1,899,538	1,705,240	1,724,265	1,682,335	− 41,930
Jackson and Jefferson	(a)	145,103	219,569	188,080	152,498	− 35,582
La Plata	96,749	132,487	140,055	132,317	117,502	− 14,815
Las Animas	4,458,753	4,708,698	3,739,357	2,693,288	2,853,847	+160,559
Mesa	92,881	114,493	134,438	163,894	101,327	− 62,567
Pitkin and Rio Blanco	(a)	(c)	54,517	65,104	52,143	− 12,961
Routt	317,791	448,261	334,961	666,384	852,315	+185,931
Weld	520,396	491,037	409,131	475,734	432,501	− 43,233
Small mines [d]	123,057	88,865	11,768	5,532	10,233	+ 4,701
Total	10,157,383	10,977,824	9,232,510	8,170,559	8,624,980	+454,421
Total value	$14,747,764	$16,345,336	$14,035,090	$13,601,718	$13,599,264	− $2,454

[a] Included with small mines.
[b] Archuleta County included with small mines; no production in Montezuma County.
[c] Pitkin County included with small mines; no production in Rio Blanco County.
[d] Includes in 1911 to 1913 counties as indicated above.

GEORGIA.

Total production in 1915, 134,496 net tons; spot value, $231,861.

The output of coal in Georgia in 1915 was 5,747 tons, or 4 per cent, less in quantity and $7,601, or 3 per cent, less in value, than in 1914. The figures published in the report of this series for 1914 inadvertently included in the total output in Georgia the refuse from washeries. The correct statistics for that year and the total quantity mined are shown in the following tables for 1914 and 1915. The total value is the same as previously given, but of course the average value per ton is greater when calculated on the basis of the smaller number of tons of commercial product.

There are but two companies engaged in the mining of coal in Georgia, and their combined statistics are published as in past years, with their permission. These companies in 1915, in view of low prices for coal and coke, decreased their output and thereby were able to maintain and even slightly better their average returns per ton.

Coal produced in Georgia, 1914 and 1915.

Year.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity of commercial coal (net tons).	Refuse from washery (net tons).	Total quantity mined (net tons).	Total value.	Average value per ton of commercial coal.	Number of employees.	Average number of days worked.
1914	85,645	1,400	7,900	45,298	140,243	26,255	166,498	$239,462	$1.71	355	207
1915	90,523	1,396	7,200	35,377	134,496	20,899	155,395	231,861	1.72	368	197

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IDAHO.

The production of coal in Idaho in 1914 and 1915 was confined to one mine in the Teton Basin coal field, in the eastern part of the State. The output of this mine, which produces a fair grade of bituminous coal, is included in the statement of the production of California. The production in Idaho from 1908 to 1913 is given in the following table:

Coal produced in Idaho, 1908–1915.

Year.	Quantity (net tons).	Value.	Year.	Quantity (net tons).	Value.
1908	5,429	$21,832	1912	2,319	$6,603
1909	4,553	19,459	1913	2,143	5,149
1910	4,448	17,426	1914	(a)	(a)
1911	1,805	4,808	1915	(a)	(a)

a Included with California.

ILLINOIS.

The coal produced in Illinois in 1915 amounted to 58,829,576 net tons, valued at $64,622,471, an increase in quantity, compared with 1914, of 1,240,379 tons, or 2.2 per cent, and a decrease in value amounting to $71,058, or 0.1 per cent. The output in 1915 was exceeded in but two years, 1912 and 1913. In the northern part of the State there was a general decrease, few counties recording increased output. In the central districts conditions were somewhat better, and Christian, Macoupin, and Montgomery counties, each with production of more than 2,000,000 tons, showed increase. Vermilion County, on the eastern border of the State, had a small increase. In the southern counties the gains were more general, and of the more important counties all but Madison, St. Clair, and Randolph, in the vicinity of St. Louis and southward, and Gallatin, on the eastern side of the State, had greater output in 1915 than in 1914.

Conditions in the coal trade in Illinois in 1915 were depressed throughout most of the year. During the summer and early in the fall the thrashing and handling of excellent crops gave some local impetus to production, but it was not until late in the fall that marked improvement was noticeable.

Shortage in cars in the eastern fields relieved the competition offered Illinois coal in Indiana and elsewhere, and this condition and the greater railroad activity following the general improvement in the iron and steel business gave an impetus to production in Illinois sufficient to increase the output in 1915 above that in 1914. No labor shortage was reported during the year, despite the fact that there were nearly 4,000, or 5 per cent, less men employed than in 1914.

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Coal produced in Illinois in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Bond, Jefferson, Washington, and White	601,468	43,842	17,288	662,598	$652,840	$0.99	832	167
Bureau	1,211,076	37,035	36,200	1,284,311	2,138,716	1.67	3,404	186
Christian	1,365,081	75,474	45,498	1,486,053	1,677,143	1.13	2,007	164
Clinton	1,040,902	13,956	35,929	1,090,787	1,110,044	1.02	1,579	153
Franklin	7,023,068	79,782	208,359	7,311,209	8,533,516	1.17	7,661	199
Fulton	1,960,370	49,534	42,266	2,052,170	2,588,881	1.26	3,407	167
Gallatin	79,540	1,575	620	81,735	84,135	1.03	129	185
Greene	.....	6,590	75	6,665	13,330	2.00	21	164
Grundy	352,299	23,657	12,412	388,368	686,992	1.77	1,264	147
Hancock, Morgan, Schuyler, Scott, and Warren	.....	7,169	.....	7,169	13,091	1.83	26	192
Henry	.....	45,232	1,778	47,010	75,791	1.61	92	213
Jackson	545,992	19,101	36,604	601,697	855,961	1.42	928	145
Knox	.....	13,650	500	14,150	27,230	1.92	36	192
La Salle	849,159	371,963	58,470	1,279,592	2,242,493	1.75	2,810	188
Livingston	12,863	47,770	3,828	64,461	106,380	1.65	87	217
Logan	250,031	73,215	28,935	352,181	460,647	1.31	748	158
McDonough	.....	5,251	.....	5,251	10,695	2.04	26	181
McLean, Putnam, and Woodford	711,170	98,842	43,929	853,941	1,428,214	1.67	2,010	202
Macon and Moultrie	216,624	128,814	18,549	363,987	521,321	1.43	*68	154
Macoupin	4,387,704	80,537	87,593	4,555,834	4,363,318	.96	5,486	166
Madison	3,369,242	93,198	83,816	3,546,256	3,509,461	.99	3,824	167
Marion	871,319	12,243	23,275	906,837	904,590	.99	1,112	202
Marshall	301,152	60,231	21,948	383,331	708,250	1.85	918	235
Menard	40,409	33,780	2,414	76,603	103,208	1.35	266	95
Mercer	342,329	16,141	14,058	372,528	538,637	1.45	479	177
Montgomery	2,526,076	29,134	42,467	2,597,677	2,636,581	1.01	2,886	182
Peoria	950,300	86,474	18,549	1,055,323	1,267,777	1.20	1,540	183
Perry	2,148,936	40,688	46,856	2,236,480	2,173,488	.97	2,574	197
Randolph	895,995	31,466	29,121	956,582	937,564	.98	1,226	169
Rock Island	.....	35,308	714	36,022	62,703	1.74	72	140
St. Clair	3,017,040	160,330	68,952	3,246,322	2,951,890	.91	4,696	132
Saline	3,640,096	28,451	78,109	3,746,656	4,034,121	1.08	5,667	171
Sangamon	5,284,214	258,576	136,805	5,679,595	5,955,278	1.05	7,150	168
Shelby	168,105	19,489	8,745	196,339	248,641	1.27	362	149
Stark	200	12,353	150	12,703	25,181	1.98	34	151
Tazewell	276,552	54,217	4,797	335,566	412,466	1.23	456	217
Vermillion	2,194,218	156,228	43,635	2,394,081	2,716,631	1.13	3,488	170
Will	117,347	13,551	5,860	136,758	240,192	1.76	379	178
Williamson	6,832,513	53,316	180,200	7,066,029	7,500,310	1.06	9,149	166
Small mines	.....	98,340	.....	98,340	175,934	1.79	.....	.....
	53,583,390	2,516,503	1,489,304	57,589,197	64,693,529	1.12	79,499	173

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Coal produced in Illinois in 1914 and 1915—Continued.

1915.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Bond, Jefferson, Washington, and White	451,730	44,970	17,005	513,705	$523,530	$1.02	666	141
Bureau	1,119,424	34,862	48,412	1,202,698	1,961,127	1.63	3,084	186
Christian	2,010,396	81,600	43,056	2,135,052	2,297,686	1.08	2,699	181
Clinton	1,257,928	14,996	42,734	1,315,648	1,239,047	.94	1,268	202
Franklin	7,767,990	52,272	207,511	8,027,773	8,813,376	1.10	9,054	171
Fulton	1,749,714	48,219	51,973	1,849,906	2,267,157	1.23	3,143	174
Gallatin	62,025	10,371	4,984	77,380	62,700	.81	159	124
Greene	.....	5,748	16	5,764	11,300	1.96	20	181
Grundy	267,581	9,154	16,925	293,660	428,414	1.46	752	175
Hancock, Morgan, Scott, and Warren	.....	3,924	.....	3,924	8,491	2.16	17	142
Henry	.....	43,839	2,380	46,219	90,373	1.96	100	221
Jackson	635,519	17,070	29,453	682,042	919,382	1.35	733	191
Knox	.....	11,535	450	11,985	22,287	1.86	35	179
La Salle	720,221	418,306	54,267	1,192,794	2,101,188	1.76	2,254	197
Livingston	8,928	53,913	500	63,341	110,367	1.74	90	196
Logan	287,458	53,501	20,387	311,346	407,070	1.31	652	160
McDonough	500	4,382	250	5,132	11,223	2.19	22	158
McLean, Marshall, Putnam, and Woodford	1,059,322	172,969	63,946	1,296,237	2,160,315	1.67	2,934	222
Macon and Moultrie	194,784	121,536	13,170	329,490	498,363	1.51	533	184
Macoupin	4,663,147	48,940	120,453	4,832,540	4,638,945	.96	5,311	168
Madison	3,251,828	95,825	72,302	3,419,955	3,355,753	.98	3,730	165
Marion	890,098	9,385	25,882	925,365	879,840	.95	1,139	196
Menard	51,478	25,753	1,662	78,893	100,455	1.27	232	112
Mercer	318,481	8,468	13,891	340,840	495,732	1.45	509	207
Montgomery	2,814,907	19,922	42,630	2,877,459	2,952,009	1.03	3,051	191
Peoria	1,087,864	85,340	20,147	1,193,351	1,472,948	1.23	1,534	196
Perry	2,302,398	36,191	45,069	2,383,658	2,357,064	.99	2,613	205
Randolph	846,817	28,277	17,854	892,948	886,844	.99	1,122	182
Rock Island	.....	24,041	706	24,747	43,510	1.76	68	130
St. Clair	2,635,062	165,320	107,747	2,908,129	2,597,864	.89	3,864	136
Saline	4,063,483	31,485	71,281	4,166,249	4,414,601	1.06	5,004	179
Sangamon	4,676,786	285,375	113,682	5,075,823	5,290,177	1.04	6,563	175
Schuyler	.....	5,864	.....	5,864	7,918	1.35	17	213
Shelby	70,834	12,693	5,145	88,672	126,458	1.43	302	89
Stark	40	11,679	200	11,919	23,772	1.99	33	205
Tazewell	202,061	56,734	4,452	263,247	330,363	1.25	454	180
Vermilion	2,261,238	152,569	55,456	2,469,263	2,754,147	1.12	2,826	198
Will	116,283	18,233	6,900	141,416	243,757	1.72	359	197
Williamson	7,030,068	44,116	190,211	7,264,395	7,550,097	1.04	8,664	182
Small mines	.....	100,747	.....	100,747	166,811	1.66	.....	.....
	54,826,393	2,470,114	1,533,069	58,829,576	64,622,471	1.10	75,610	179

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Coal produced in Illinois, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Bond, Jefferson, Washington, and White	[a] 190,831	[a] 526,690	600,460	661,892	513,705	— 148,187
Bureau	1,628,688	1,677,317	1,639,208	1,284,311	1,202,698	— 81,613
Christian	1,222,259	1,467,846	1,504,716	1,486,053	2,135,052	+ 648,999
Clinton	921,225	1,040,479	1,049,575	1,090,787	1,315,648	+ 224,861
Franklin	3,555,586	4,442,284	6,072,102	7,311,209	8,027,773	+ 716,564
Fulton	2,133,029	2,453,424	2,388,775	2,052,170	1,849,906	— 202,264
Gallatin	63,008	64,244	46,105	81,735	77,380	— 4,355
Greene	(b)	7,841	(b)	6,665	5,764	— 901
Grundy	776,800	540,787	401,527	388,368	293,660	— 94,708
Hancock, Morgan, Schuyler, Scott, and Warren	[b] 23,351	[c] 11,054	[b] [c] 12,069	7,169	9,788	+ 2,619
Henry	90,722	58,613	43,383	47,010	46,219	— 791
Jackson	687,753	703,190	723,863	601,697	682,042	+ 80,345
Knox	30,136	22,293	18,280	14,150	11,985	— 2,165
La Salle	1,610,470	1,537,591	1,564,459	1,279,592	1,192,794	— 86,798
Livingston	89,423	65,774	63,877	64,461	63,341	— 1,120
Logan	334,860	466,528	351,666	352,181	311,346	— 40,835
McDonough	8,027	14,446	12,603	5,251	5,132	— 119
McLean, Putnam, and Woodford	1,033,494	995,328	994,997	853,941	[d] 1,296,237	+ 442,296
Macon and Moultrie	[e] 236,203	372,570	326,274	363,087	329,490	— 34,497
Macoupin	4,688,212	4,986,574	5,097,619	4,555,834	4,832,540	+ 276,706
Madison	3,152,705	4,025,878	3,732,153	3,546,256	3,419,955	— 126,301
Marion	1,224,326	1,311,024	988,964	906,837	925,365	+ 18,528
Marshall	423,984	449,660	426,490	383,331	(d)	— 383,331
Menard	190,477	177,578	120,174	76,603	78,893	+ 2,290
Mercer	297,552	393,018	408,875	372,528	340,840	— 31,688
Montgomery	2,395,814	2,182,823	2,689,702	2,597,677	2,877,459	+ 279,782
Peoria	1,037,362	1,225,574	1,163,073	1,055,323	1,193,351	+ 138,028
Perry	1,272,292	1,444,114	2,013,128	2,236,480	2,383,658	+ 147,178
Randolph	777,746	798,163	763,472	956,582	892,948	— 63,634
Rock Island	65,983	66,817	35,672	36,022	24,747	— 11,275
St. Clair	3,931,479	4,734,840	4,383,459	3,246,322	2,908,129	— 338,193
Saline	3,820,410	4,417,874	4,189,003	3,746,656	4,166,249	+ 419,593
Sangamon	5,137,835	5,714,742	5,875,853	5,679,595	5,075,823	— 603,772
Shelby	81,615	185,501	193,632	196,339	88,672	— 107,667
Stark	37,293	34,176	14,610	12,703	11,919	— 784
Tazewell	220,783	271,321	341,626	335,566	263,247	— 72,319
Vermilion	3,385,200	3,434,923	3,501,880	2,394,081	2,469,263	+ 75,182
Will	178,397	130,806	149,026	136,758	141,416	+ 4,658
Williamson	6,614,029	7,354,507	7,644,397	7,066,029	7,264,395	+ 198,366
Small mines	109,759	77,014	71,097	99,046	100,747	+ 1,701
Total	53,679,118	59,885,226	61,618,744	57,589,197	58,829,576	+1,240,379
Total value	$59,519,478	$70,294,338	$70,313,605	$64,693,529	$64,622,471	— $71,058

[a] Bond, etc., includes Calhoun County.
[b] Hancock, etc., includes Greene County.
[c] No production in Hancock County.
[d] McLean, etc., includes Marshall County.
[e] Macon County only.

INDIANA.

Total production in 1915, 17,006,152 net tons; spot value, $18,637,476.

The production of coal in Indiana in 1915 was about on a par with that in 1914 until the last two months of the year, but in November it received an impetus which, although coming late, served to increase the total for the year 365,020 short tons, or 2 per cent, over 1914. Cold weather in May, normally a warm month, assisted the sales of domestic coal, which were otherwise below the general average. The shortage in cars and labor at the end of the year in the eastern fields, with which Indiana comes into competition, benefited the Indiana producers, who had abundant supply of labor and cars. The increase all took place in Greene, Knox, Pike, and Vermilion counties, all others recording decrease. In Greene and Pike counties the gains were

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made at a sacrifice of value, but Knox shows the same average value per ton, and Vermilion recorded an increase from $1.10 to $1.15. A cooperative selling organization among Indiana producers was initiated in 1915, but its efforts are too recent to enable a forecast of possible results. It is not expected that an increase in selling values will result, but rather that economies in selling will be obtained that will enable the producers to show greater net incomes.

The number of men employed in the coal mines of Indiana decreased from 23,175 in 1914 to 22,777 in 1915, but the days worked increased from 168 to 179.

Coal produced in Indiana in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Clay	398,886	36,407	18,716	454,009	$630,913	$1.29	1,172	141
Daviess	74,957	10,701	5,950	91,608	115,444	1.26	171	189
Dubois and Martin	.....	5,100	300	5,400	8,250	1.53	10	230
Fountain and Warren	36,891	3,673	200	40,764	54,131	1.33	88	127
Gibson	240,993	30,404	9,239	280,636	300,602	1.07	340	202
Greene	2,118,620	46,901	64,564	2,230,085	2,451,122	1.10	3,108	157
Knox	1,528,826	36,073	54,184	1,619,083	1,626,663	1.00	1,638	185
Owen	110,317	1,038	.....	111,355	148,309	1.33	105	293
Parke	308,365	13,836	9,644	331,845	381,309	1.15	513	178
Perry	.....	13,800	.....	13,800	17,550	1.27	26	238
Pike	538,015	29,748	10,930	578,693	645,145	1.11	1,115	149
Spencer	.....	8,510	.....	8,510	11,382	1.34	16	195
Sullivan	2,872,723	38,792	87,633	2,999,148	3,228,204	1.08	3,787	167
Vanderburg	150,172	129,922	8,097	288,191	387,255	1.34	439	199
Vermilion	2,057,129	13,334	65,373	2,135,836	2,342,775	1.10	2,968	159
Vigo	4,521,653	148,104	98,071	4,767,828	5,258,500	1.10	6,837	175
Warrick	540,451	63,143	21,176	624,770	598,267	.96	842	166
Small mines	.....	59,571	.....	59,571	85,107	1.43	.....	.....
	15,497,998	689,057	454,077	16,641,132	18,290,928	1.10	23,175	168

1915.

Clay	251,461	27,407	16,583	295,451	$411,709	$1.39	991	110
Daviess	61,429	13,982	3,650	79,061	98,982	1.25	139	182
Dubois and Martin	.....	3,000	.....	3,000	4,212	1.40	11	173
Fountain and Warren	21,000	2,400	400	23,800	27,520	1.16	42	172
Gibson	247,565	15,503	8,109	271,177	283,640	1.05	390	185
Greene	2,207,724	44,623	72,287	2,324,634	2,493,390	1.07	2,720	175
Knox	2,124,081	39,339	48,895	2,212,315	2,222,250	1.00	2,102	218
Owen	82,153	1,465	7,700	91,318	100,029	1.10	63	180
Parke	143,786	7,095	15,767	166,648	294,067	1.76	461	125
Perry	.....	11,075	.....	11,075	14,213	1.28	20	247
Pike	619,269	17,257	9,640	646,166	697,892	1.08	1,015	140
Spencer	576	6,119	.....	6,695	9,609	1.44	18	174
Sullivan	2,495,150	30,625	61,333	2,587,108	2,760,817	1.07	3,931	158
Vanderburg	105,259	115,050	7,022	227,331	310,793	1.37	441	159
Vermilion	2,671,866	6,623	56,057	2,734,546	3,138,355	1.15	3,686	195
Vigo	4,495,377	94,514	98,947	4,688,838	5,125,847	1.09	5,968	193
Warrick	506,343	52,168	18,962	577,473	560,913	.97	779	178
Small mines	.....	59,516	.....	59,516	83,238	1.40	.....	.....
	16,033,039	547,761	425,352	17,006,152	18,637,476	1.10	22,777	179

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Coal produced in Indiana, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Clay	779,372	700,323	564,957	454,009	295,451	− 158,558
Daviess	79,466	105,079	84,030	91,608	79,061	− 12,547
Dubois and Martin	4,119	16,500	7,948	5,400	3,000	− 2,400
Fountain and Warren	5,625	5,066	64,902	40,764	23,800	− 16,964
Gibson	247,128	228,557	227,100	280,636	271,177	− 9,459
Greene	2,563,366	2,636,509	2,790,708	2,230,085	2,324,634	+ 94,549
Knox	879,323	1,212,596	1,760,748	1,619,083	2,212,315	+ 593,232
Owen	22,693	30,707	127,283	111,355	91,318	− 20,037
Parke	521,567	523,150	507,508	331,845	166,648	− 165,197
Perry	16,683	15,904	14,910	13,800	11,075	− 2,725
Pike	467,623	559,337	583,637	578,693	646,166	+ 67,473
Spencer	9,551	10,306	8,479	8,510	6,695	− 1,815
Sullivan	3,261,787	3,091,368	3,084,419	2,999,148	2,587,108	− 412,040
Vanderburg	279,109	302,074	280,522	288,191	227,331	− 60,860
Vermilion	1,673,621	1,547,126	2,085,311	2,135,836	2,734,546	+ 598,710
Vigo	2,793,352	3,564,046	4,237,274	4,767,828	4,688,838	− 78,990
Warrick	545,132	691,475	685,020	624,770	577,473	− 47,297
Small mines	51,838	45,595	60,915	59,571	59,516	− 55
Total	14,201,355	15,285,718	17,165,671	16,641,132	17,006,152	+ 365,020
Total value	$15,326,808	$17,480,546	$19,001,881	$18,290,928	$18,637,476	+$346,548

IOWA.

The production of coal in Iowa in 1915 amounted to 7,614,143 net tons, valued at $13,577,608, which represents an increase of 163,121 tons, or 2 per cent, in quantity and of $213,538, or 1.6 per cent, in value compared with 1914, and was exceeded in only two previous years, 1909 and 1910. The largest increases occurred in Dallas, Jasper, Marion, Polk, and Wapello counties. The number of men employed decreased from 16,057 in 1914 to 15,549 in 1915, but the days worked increased from 204 to 220. The largest use for Iowa coal is by railroads and for domestic purposes, as Iowa is primarily an agricultural State crossed by many of the western trunk lines. That the production of coal in this State, which for 10 years has ranged between seven and eight million tons, has not kept pace with the increase in population and in railroad activities is owing to the inroads that coal from other States, both east and west, have made on the natural markets for Iowa coal.

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Coal produced in Iowa in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Adams	.....	6,660	.....	6,660	$16,650	$2.50	47	232
Appanoose	1,195,603	64,383	12,290	1,272,276	2,505,646	1.97	4,084	168
Boone	125,462	46,970	9,520	181,952	368,175	2.02	556	177
Dallas	449,092	7,794	9,811	466,697	877,565	1.88	861	228
Greene, Lucas, and Warren	289,344	10,038	2,750	302,132	518,676	1.72	474	247
Guthrie	.....	3,925	.....	3,925	10,793	2.75	31	136
Jasper	214,166	22,325	5,500	241,991	532,398	2.20	531	190
Jefferson, Keokuk, and Van Buren	.....	13,149	.....	13,149	32,439	2.47	32	187
Mahaska	243,885	23,975	5,008	272,868	400,722	1.47	522	206
Marion	284,791	15,805	10,587	311,183	498,894	1.60	573	225
Monroe	2,147,252	61,719	64,095	2,273,066	3,646,662	1.60	4,165	211
Page and Taylor	5,000	4,827	75	9,902	24,493	2.47	45	172
Polk	1,413,350	262,883	30,566	1,706,779	3,219,218	1.89	3,188	228
Wapello	206,458	26,508	4,210	237,176	409,177	1.73	596	231
Wayne	70,420	4,904	1,200	76,524	151,096	1.97	243	192
Webster	31,569	873	1,250	33,692	76,614	2.27	109	208
Small mines	.....	41,050	.....	41,050	74,854	1.82	.....	.....
	6,676,392	617,768	156,862	7,451,022	13,364,070	1.79	16,057	204

1915.

Adams	120	8,120	100	8,340	$21,300	$2.55	45	174
Appanoose	1,147,423	57,508	20,169	1,225,100	2,376,497	1.94	4,139	245
Boone	109,731	41,384	5,145	156,260	329,676	2.11	447	195
Dallas	449,262	11,219	10,400	470,881	905,355	1.92	863	214
Greene, Lucas, Warren, and Wayne	574,917	16,717	6,150	597,784	1,071,692	1.79	922	232
Guthrie	.....	3,968	.....	3,968	10,887	2.74	27	157
Jasper	252,096	15,961	110	268,167	555,030	2.07	514	223
Jefferson, Keokuk, and Van Buren	.....	6,710	.....	6,710	16,286	2.43	25	183
Mahaska	229,403	13,765	2,618	245,786	395,629	1.61	432	192
Marion	322,242	28,116	9,797	360,155	552,968	1.54	782	218
Monroe	2,058,876	40,841	57,632	2,157,349	3,418,329	1.58	3,704	206
Page and Taylor	4,000	4,617	.....	8,617	21,543	2.50	49	182
Polk	1,509,531	203,685	31,088	1,744,304	3,255,677	1.87	2,932	223
Wapello	298,717	15,626	4,650	313,993	549,467	1.75	589	179
Webster	12,380	6,225	300	18,905	41,025	2.17	79	147
Small mines	.....	27,824	.....	27,824	56,247	2.02	.....	.....
	6,963,696	502,283	148,159	7,614,143	13,577,608	1.78	15,549	220

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Coal produced in Iowa in 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Adams	7,472	9,868	6,971	6,660	8,340	+ 1,680
Appanoose	1,104,723	1,252,666	1,207,387	1,272,276	1,225,100	− 47,176
Boone	214,440	212,168	256,212	181,952	156,260	− 25,692
Dallas	385,588	436,206	574,186	466,697	470,881	+ 4,184
Greene, Lucas, and Warren	26,637	28,644	40,934	302,132	[a] 597,784	+ 295,652
Guthrie	10,390	5,870	4,492	3,925	3,968	+ 43
Jasper	292,427	271,301	267,567	241,991	268,167	+ 26,176
Jefferson, Keokuk, and Van Buren	26,297	27,692	21,785	13,149	6,710	− 6,439
Mahaska	777,189	578,843	355,737	272,868	245,786	− 27,082
Marion	171,329	182,068	298,552	311,183	360,155	+ 48,972
Monroe	2,259,239	2,393,412	2,571,277	2,273,066	2,157,349	− 115,717
Page and Taylor	22,346	10,170	7,473	9,902	8,617	− 1,285
Polk	1,532,010	1,486,053	1,601,015	1,706,779	1,744,304	+ 37,525
Wapello	312,332	206,102	153,705	237,176	313,993	+ 76,817
Wayne	116,382	99,168	85,775	76,524	(a)	− 76,524
Webster	46,026	48,074	45,676	33,692	18,905	− 14,787
Small mines	26,821	[b] 41,224	27,192	41,050	27,824	− 13,226
Total	7,331,648	7,299,529	7,525,936	7,451,022	7,614,143	+ 163,121
Total value	$12,663,507	$13,152,088	$13,496,710	$13,364,070	$13,577,608	+$213,538

[a] Greene, etc., includes Wayne County.

[b] Includes Scott County.

KANSAS.

The coal produced in Kansas in 1915 amounted to 6,824,474 net tons, valued at $11,360,630, a slight decrease, 36,514 tons, or less than 1 per cent, in quantity, but an increase, $122,377, or 1 per cent, in value. In common with the other coal-producing States in the southwestern territory Kansas depends on the railroads as the principal market for its coal. The well-directed efforts of the railroad officials in effecting economy in the use of coal and the large use of oil as fuel have tended to curtail production of coal in the southwestern area during the last few years. The improvement in business apparent throughout the Eastern States in 1915 was not very strongly felt west of the Mississippi, except in the metal-mining and smelting industries. Southeastern Kansas is a zinc-smelting center, and the intense activity in that branch of business, which, though here depending largely upon natural gas for fuel, uses considerable quantities of coal, assisted the Kansas producers to attain nearly the record of 1914 in output of coal.

The mining of coal in open pits by means of steam shovels has become an important feature in the coal fields in Crawford and Cherokee counties. This method of mining has effected large economies in the cost of operation as compared with underground systems and has given these fields, in which the coal beds are thin and expensive to mine, a new lease on life. There were 23 shovels at work in Kansas at the end of 1915, and more than 780,000 tons (11 per cent of the State total) were taken from the steam-shovel pits. The statistics of steam-shovel operations in coal mining in the United States are given on page 373.

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Coal produced in Kansas in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Cherokee	1,822,503	18,702	41,605	1,882,810	$3,039,897	$1.61	2,898	199
Crawford	4,584,961	57,537	109,626	4,752,114	7,686,133	1.62	8,474	190
Franklin and Leavenworth	58,644	45,909	7,400	111,953	231,704	2.07	467	247
Linn	4,800	5,680	.....	10,480	17,840	1.70	21	252
Osage	82,345	5,840	186	88,371	228,966	2.59	588	135
Small mines	.....	15,260	.....	15,260	33,713	2.21	.....	.....
	6,553,243	148,928	158,817	6,860,988	11,238,253	1.64	12,448	192

1915.

Cherokee	1,165,555	8,429	33,472	1,707,456	$2,786,419	$1.63	2,834	187
Crawford	4,672,842	56,274	114,116	4,843,232	7,943,164	1.64	9,094	182
Leavenworth	106,206	10,523	36,326	153,055	329,898	2.16	690	238
Linn	2,541	8,000	.....	10,541	20,276	1.92	30	202
Osage	88,728	11,894	157	100,779	259,186	2.56	612	151
Small mines	.....	9,411	.....	9,411	22,687	2.41	.....	.....
	6,535,872	104,531	184,071	6,824,474	11,360,630	1.66	13,260	184

Coal produced in Kansas, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Cherokee	2,036,052	2,332,944	2,259,019	1,882,810	1,707,456	− 175,354
Crawford	3,778,242	4,255,415	4,614,257	4,752,114	4,843,232	+ 91,118
Leavenworth	206,049	204,523	161,209	110,791	153,055	+ 42,264
Linn	27,366	33,588	25,212	10,480	10,541	+ 61
Osage	104,479	135,796	115,810	88,371	100,779	+ 12,408
Small mines	[a] 26,540	[b] 23,916	[c] 26,703	[c] 16,422	9,411	− 7,011
Total	6,178,728	6,986,182	7,202,210	6,860,988	6,824,474	− 36,514
Total value	$9,473,572	$11,324,130	$12,036,292	$11,238,253	$11,360,630	+$122,377

[a] Includes Atchison, Franklin, and Neosho counties.
[b] Includes Franklin and Neosho counties.
[c] Includes Franklin County.

KENTUCKY.

In the 20 years from 1896 to 1915 the production of coal in Kentucky increased nearly 600 per cent, from 3,333,478 net tons in 1896 to 21,361,674 tons in 1915. During this period there have been only two years, 1908 and 1911, in which the output of the State showed decrease. The increase in 1915 over 1914 was 978,911 tons, or about 5 per cent. The value of the product at the mines in 1915 was $21,494,008, an increase of $641,545, or 3.1 per cent. The steady climb of Kentucky among the coal-producing States has been largely due in the last five years to the remarkable developments in the eastern fields, particularly in Perry, Pike, Letcher, Harlan, and Floyd counties, and to the additional output from both old and new developments in these counties and in Johnson County is due the greater output in 1915 compared with that in 1914. Eastern Kentucky's high-volatile coal, particularly that from some of the easternmost counties, has been found to be excellent for making by-product

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coke and for use in gas plants, and large quantities are each year shipped for these purposes to the Chicago district, to points in Indiana, Illinois, and Michigan, and to St. Louis. The coal from eastern Kentucky is also sought for domestic use and for steam. The greater part of the coal from these counties finds a market north of Ohio River and meets in competition the coals from Ohio, Pennsylvania, Indiana, and West Virginia. The producing districts in the southeastern part of the State, adjoining Tennessee, all recorded decreased output, as did the western part of the State.

The average value per ton in the eastern part of Kentucky decreased from $1.13 to $1.10, nearly 3 per cent, and in the western part from 85 to 84 cents. The only counties to record greater average values in 1915 were McCreary and Whitley, on the southeastern border, and Christian, Henderson, McLean, and Ohio, in the western district.

There was a decrease in the number of men employed in both the eastern and the western districts, but the average days worked increased in eastern Kentucky from 203 to 205 and decreased in western Kentucky from 159 to 154.

Coal produced in Kentucky in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Eastern district:									
Bell	2,485,928	63,840	29,243	.....	2,579,011	$2,854,188	$1.11	4,095	208
Boyd	87,137	4,213	1,532	.....	92,882	80,775	.87	174	174
Breathitt, Knott, Lawrence, and Lee	105,324	5,063	2,835	.....	113,242	128,927	1.14	281	131
Carter	64,936	19,169	370	.....	84,475	90,963	1.08	141	183
Floyd	511,780	5,693	7,450	.....	524,923	579,064	1.10	936	158
Harlan	999,057	10,647	14,659	239,703	1,264,066	1,387,650	1.10	1,461	216
Johnson	896,345	9,268	30,017	.....	935,630	1,260,252	1.35	1,476	215
Knox	856,788	23,825	24,071	.....	904,684	980,562	1.08	1,396	208
Laurel	93,788	6,320	1,097	.....	101,205	105,441	1.04	285	166
Letcher	1,400,624	10,725	16,277	.....	1,427,626	1,769,298	1.24	1,694	241
McCreary	578,376	5,529	2,636	.....	586,541	589,968	1.01	1,140	173
Morgan	61,519	14,253	256	.....	76,028	167,308	2.20	272	241
Perry	216,325	2,509	2,178	.....	221,012	261,460	1.18	516	189
Pike	2,468,013	21,680	50,868	112,754	2,653,315	2,665,002	1.00	2,735	219
Pulaski and Rockcastle	.....	3,100	.....	.....	3,100	4,740	1.53	18	156
Whitley	824,146	11,899	17,974	.....	854,019	1,115,594	1.31	1,807	170
	11,650,086	217,753	201,463	352,457	12,421,759	14,041,192	1.13	18,427	203
Western district:									
Christian and McLean	80,424	2,727	754	.....	83,905	74,470	.89	263	120
Daviess	.....	47,188	350	.....	47,538	45,640	.96	65	231
Hancock	.....	7,000	.....	.....	7,000	10,400	1.49	11	200
Henderson	80,895	72,141	8,030	.....	161,066	177,757	1.10	243	151
Hopkins	2,356,392	54,100	97,105	44,123	2,551,720	2,050,066	.80	2,915	160
Muhlenberg	2,178,262	38,720	48,171	.....	2,265,153	1,961,844	.87	3,607	147
Ohio	616,991	17,592	25,690	.....	660,273	516,181	.78	1,085	151
Union	509,875	40,358	35,510	.....	585,743	567,065	.97	677	186
Webster	1,423,210	17,524	35,056	.....	1,475,790	1,239,581	.84	1,471	188
	7,246,049	297,350	250,666	44,123	7,838,188	6,643,004	.85	10,337	159
Small mines	.....	122,816	.....	.....	122,816	168,267	1.37	.....	.....
Grand total	18,896,135	637,919	452,129	396,580	20,382,763	20,852,463	1.02	28,764	187

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Coal produced in Kentucky in 1914 and 1915—Continued.

1915.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Eastern district:									
Bell	2,210,498	47,769	48,564	.....	2,306,831	$2,414,790	$1.05	3,551	209
Boyd	73,211	2,871	1,918	.....	78,000	65,872	.84	164	191
Breathitt, Greenup, Knott, Lawrence, and Lee	67,401	6,218	973	.....	74,592	77,541	1.04	114	207
Carter	65,152	3,649	14,612	.....	83,413	89,669	1.08	161	179
Floyd	510,059	26,164	8,851	.....	545,074	566,174	1.04	711	178
Harlan	1,390,346	12,312	15,677	308,463	1,726,798	1,827,144	1.06	1,496	226
Jackson and Pulaski	1,837	3,581	.....	.....	5,418	6,895	1.27	17	147
Johnson	928,645	17,897	28,922	.....	975,464	1,267,332	1.30	1,282	221
Knox	746,796	5,043	15,874	.....	767,713	815,986	1.06	1,480	195
Laurel	84,302	55	779	.....	85,136	84,896	.99	229	143
Letcher	2,204,129	12,234	12,971	.....	2,229,334	2,656,628	1.19	2,159	226
McCreary	566,767	1,781	987	.....	569,535	642,244	1.13	970	173
Morgan	51,410	5,762	1,643	.....	58,815	128,450	2.18	202	254
Perry	532,998	2,261	12,703	.....	547,962	615,690	1.12	724	242
Pike	2,648,211	37,043	50,913	94,072	2,830,239	2,689,525	.95	2,928	211
Whitley	776,450	7,684	21,312	.....	805,446	1,068,984	1.33	1,782	162
	12,858,212	192,324	236,699	402,535	13,689,770	15,018,120	1.10	17,970	205
Western district:									
Christian and McLean	92,356	350	550	.....	93,256	85,503	.92	184	176
Daviess	6,000	35,320	1,458	.....	42,778	41,157	.96	67	232
Hancock	1,000	3,000	.....	.....	4,000	5,425	1.36	12	190
Henderson	103,787	52,896	10,021	.....	166,704	184,834	1.11	261	195
Hopkins	2,129,808	49,568	97,197	55,570	2,332,143	1,843,827	.79	2,737	149
Muhlenberg	2,159,213	22,559	50,273	.....	2,232,045	1,844,506	.83	3,451	143
Ohio	463,168	33,906	22,746	.....	519,820	417,373	.80	1,108	111
Union	653,818	47,679	40,613	.....	742,110	708,440	.95	756	213
Webster	1,354,030	19,214	35,756	.....	1,409,000	1,172,929	.83	1,414	176
	6,963,180	264,492	258,614	55,570	7,541,856	6,303,994	.84	9,990	154
Small mines	.....	130,048	.....	.....	130,048	171,894	1.32	.....	.....
Grand total	19,821,392	586,864	495,313	458,105	21,361,674	21,494,008	1.01	27,960	186

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Coal produced in Kentucky, 1912–1915, in net tons.

County.	1912	1913	1914	1915	Increase or decrease, 1915.
Eastern district:					
Bell	2,200,077	2,488,538	2,579,011	2,306,831	– 272,180
Boyd	100,758	131,208	92,882	78,000	– 14,882
Breathitt, Greenup, Lawrence, and Lee	151,655	105,396	[a] [b] 113,242	[b] 74,592	– 38,650
Carter	87,333	110,595	84,475	83,413	– 1,062
Floyd	446,774	445,949	524,923	545,074	+ 20,151
Harlan	332,392	750,267	1,264,066	1,726,798	+ 462,732
Johnson	932,230	861,189	935,630	975,464	+ 39,834
Knox	840,872	961,492	904,684	767,713	– 136,971
Laurel	226,990	196,569	101,205	85,136	– 16,069
Letcher	[c] 193,923	(d)	1,427,626	2,229,334	+ 801,708
McCreary	543,307	625,101	586,541	569,535	– 17,006
Morgan	89,958	90,346	76,028	58,815	– 17,213
Perry	(c)	24,953	221,012	547,962	+ 326,950
Pike	1,406,462	2,124,041	2,653,315	2,830,239	+ 176,924
Whitley	999,985	1,015,370	854,019	805,446	– 48,573
Other counties [d]	5,044	1,107,833	3,100	5,418	+ 2,318
	8,557,760	11,038,847	12,421,759	13,689,770	+1,268,011
Western district:					
Christian	60,139	69,525	[e] 83,905	[e] 93,256	+ 9,351
Daviess	90,025	48,543	47,538	42,778	– 4,760
Hancock	3,800	6,280	7,000	4,000	– 3,000
Henderson	236,159	220,582	161,066	166,704	+ 5,638
Hopkins	2,549,113	2,534,821	2,551,720	2,332,143	– 219,577
McLean	122,331	83,329	(e)	(e)	.....
Muhlenberg	2,368,037	2,633,271	2,265,153	2,232,045	– 33,108
Ohio	661,386	775,545	660,273	519,820	– 140,453
Union	550,421	690,968	585,743	742,110	+ 156,367
Webster	1,172,484	1,394,663	1,475,790	1,409,000	– 66,790
Total	7,813,895	8,457,527	7,838,188	7,541,856	– 296,332
Small mines	118,866	120,226	122,816	130,048	+ 7,232
Grand total	16,490,521	19,616,600	20,382,763	21,361,674	+ 978,911
Total value	$16,854,207	$20,516,749	$20,852,463	$21,494,008	+ $641,545

[a] No production in Greenup County.
[b] Includes Knott County.
[c] Letcher and Perry counties combined.
[d] Other counties include Clay, Magoffin, Pulaski, and Rockcastle in 1912; Clay, Letcher, and Pulaski in 1913; Clay, Pulaski, and Rockcastle, in 1914; Jackson and Pulaski in 1915.
[e] Christian and McLean counties combined.

MARYLAND.

Although the markets for Maryland coal were somewhat restricted during the early months of 1915, and shortage in cars interfered greatly with the output in December, the record for the year shows an increase over 1914 of 1 per cent in quantity and of nearly 2 per cent in value. The output in 1915 was 4,180,477 net tons, valued at $5,330,845, compared with 4,133,547 tons, valued at $5,234,796, in 1914. The increase occurred in Garrett County, which in 1915 produced 782,976 tons, against 671,621 in 1914. Allegany County decreased from 3,449,365 tons in 1914 to 3,388,365 tons in 1915.

Of the coal for which Maryland is famous, it is generally understood that the Elk Garden is entirely worked out and that the Big Vein Georges Creek is fast approaching exhaustion. When the extent of the lower but thinner beds is more fully realized and when labor can be obtained to mine these thinner beds at rates comparable with those in fields in adjacent States, the production of Maryland may be expected to increase again to the record output of about five and a half million tons of 1906 and 1907.

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The number of men employed in the Maryland mines increased from 5,403 to 5,664 and the average number of days the men worked increased from 241 in 1914 to 242 in 1915. The average output per man for the year was 739 tons, compared with 765 tons in 1914, and the average daily output was 3.05 tons in 1915, against 3.17 in 1914. Over 90 per cent of the coal in Maryland is mined by hand.

Coal produced in Maryland in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Allegany	3,363,914	28,210	57,241	3,449,365	$4,629,031	$1.34	4,430	251
Garrett	655,708	8,798	7,115	671,621	591,424	.88	973	196
Small mines	.....	12,561	.....	12,561	14,341	1.14	.....	.....
	4,019,622	49,569	64,356	4,133,547	5,234,796	1.27	5,403	241

1915.

Allegany	3,308,100	22,234	58,031	3,388,365	$4,599,962	$1.36	4,728	248
Garrett	768,881	7,538	6,557	782,976	720,214	.92	936	212
Small mines	.....	9,136	.....	9,136	10,669	1.17	.....	.....
	4,076,981	38,908	64,588	4,180,477	5,330,845	1.28	5,664	242

Coal produced in Maryland, 1912–1915, in net tons.

County.	1912	1913	1914	1915	Increase or decrease, 1915.
Allegany	4,136,810	4,038,261	3,449,365	3,388,365	− 61,000
Garrett	810,319	731,089	671,621	782,976	+111,355
Small mines	16,909	10,489	12,561	9,136	− 3,425
Total	4,964,038	4,779,839	4,133,547	4,180,477	+ 46,930
Total value	$5,839,079	$5,927,046	$5,234,796	$5,330,845	+$96,049

MICHIGAN.

The coal produced in Michigan in 1915 amounted to 1,156,138 net tons, valued at $2,372,797.

The consumption of coal in Michigan is increasing every year, but coal from other States supplies a large part of this market and the decrease in output in the Michigan field in 1915, which amounted to 126,892 tons, is attributed to that cause rather than to any decrease in industrial or railroad activity. The output of coal in Michigan in 1914 was 1,283,030 tons, valued at $2,559,786.

There were 2,569 men employed in the coal mines of the State in 1915, and they worked for an average of 198 days. In 1914 the number of employees was 2,800 and the average number of days each worked was 201. The average value per ton in 1915, $2.05, was 6 cents greater than in 1914 and exceeds any record for the State in recent years

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Coal produced in Michigan in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Bay	579,435	5,706	32,274	617,415	$1,215,469	$1.97	1,292	188
Genesee, Ingham, and Tuscola	65,551	5,201	10,114	80,866	149,660	1.86	318	204
Saginaw	513,918	48,194	22,536	584,648	1,194,430	2.04	1,190	214
Small mines	.....	101	.....	101	227	2.25	.....	.....
	1,158,904	59,202	64,924	1,283,030	2,559,786	1.99	2,800	201

1915.

Bay	530,548	2,541	18,683	551,772	$1,061,452	$1.96	1,206	194
Ingham and Tuscola	54,670	2,530	7,450	64,650	162,569	2.51	175	193
Saginaw	492,727	36,723	9,586	539,036	1,126,717	2.09	1,188	202
Small mines	.....	680	.....	680	2,059	3.03	.....	.....
	1,077,945	42,474	35,719	1,156,138	2,372,797	2.05	2,569	198

Coal produced in Michigan, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Bay	717,084	630,981	591,718	617,415	551,772	− 65,643
Eaton	1,000	.....	.....	.....	.....	.....
Saginaw	667,954	504,612	596,193	584,648	539,036	− 45,612
Tuscola	[a] 90,036	[b] 70,476	[c] 42,715	[d] 80,866	[e] 64,650	− 16,216
Small mines	(*f*)	211	1,160	101	680	+ 579
Total	1,476,074	1,206,230	1,231,786	1,283,030	1,156,138	− 126,892
Total value	$2,791,461	$2,399,451	$2,455,227	$2,559,786	$2,372,797	−$186,989

[a] Includes Clinton, Genesee, Ingham, Shiawassee counties and small mines.
[b] Includes Clinton and Ingham counties.
[c] Includes Clinton, Ingham, and Shiawassee counties.
[d] Includes Genessee and Ingham counties.
[e] Includes Ingham County.
[f] Included with Tuscola County.

MISSOURI.

The production of coal in Missouri in 1915 was 3,811,593 net tons, valued at $6,595,918, a decrease compared with 1914 of 124,387 tons, or 3 per cent, in quantity and of $206,407, or 3 per cent, in value. The falling off in railroad demand was the principal factor causing the decrease, although mild weather during the winter months resulted in a small consumption of coal for domestic use. Railroad and general commercial demand for coal improved to such an extent late in the year that the production in 1916 is expected to exceed that in 1915, which was the lowest in five years. The number of men employed in the coal mines of Missouri (9,173) was 376 less than in 1914, but the men worked an average of 186 days, as against 179 days in 1914.

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Coal produced in Missouri in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Adair	218,542	31,042	6,813	256,397	$406,776	$1.59	672	170
Audrain	4,936	5,166	258	10,360	21,579	2.08	57	168
Barton	486,992	7,112	11,178	505,282	824,974	1.63	643	201
Bates	126,447	13,645	4,939	145,031	231,146	1.59	244	184
Boone	1,165	11,301	48	12,514	27,030	2.16	57	137
Callaway	8,473	29,482	1,600	39,555	83,730	2.12	141	230
Caldwell, Clay, Dade, Johnson, and Platte	81,391	26,736	2,432	110,559	243,127	2.20	372	204
Cooper and Moniteau	.....	3,032	.....	3,032	5,947	1.96	11	161
Grundy, Harrison, Schuyler, and Sullivan	91,631	15,553	7,765	114,949	188,040	1.64	289	158
Henry	181,740	40,579	2,575	224,894	360,386	1.60	442	203
Howard and Ralls	23,364	36	500	23,900	44,014	1.84	70	236
Lafayette	645,111	41,076	16,842	703,029	1,316,396	1.87	2,243	184
Linn	80,680	25,331	2,615	108,626	249,252	2.29	394	204
Macon	733,703	21,037	10,625	765,365	1,208,804	1.58	1,555	180
Putnam	7,080	3,087	200	10,367	16,613	1.60	103	58
Randolph	391,435	26,885	5,925	424,245	668,111	1.57	956	173
Ray	292,762	25,304	6,014	324,080	611,176	1.89	1,201	149
Vernon	41,688	1,177	300	43,165	72,303	1.68	99	181
Small mines	.....	110,630	.....	110,630	222,921	2.02	.....	.....
	3,417,140	438,211	80,629	3,935,980	6,802,325	1.73	9,549	179

1915.

Adair	261,052	11,734	7,401	280,187	$443,209	$1.58	894	140
Audrain	5,780	7,745	278	13,803	32,184	2.33	51	228
Barton	635,952	4,111	17,006	657,069	1,085,391	1.65	860	183
Bates	61,912	6,916	2,484	71,312	111,756	1.57	165	140
Boone	.....	17,450	.....	17,450	38,141	2.19	46	186
Callaway	32,770	29,494	1,872	64,136	128,089	2.00	129	261
Caldwell, Clay, Dade, Johnson, and Platte	60,089	27,534	1,391	88,964	194,141	2.18	347	206
Cooper and Moniteau	1,500	1,850	.....	3,350	9,500	2.84	9	200
Grundy, Harrison, and Sullivan	79,402	16,061	8,418	103,881	175,030	1.69	168	178
Henry	157,233	23,279	2,799	183,311	305,781	1.67	454	193
Lafayette	710,629	64,986	23,682	799,297	1,492,049	1.87	2,383	200
Linn	76,101	19,352	1,789	97,242	228,172	2.35	341	213
Macon	638,592	19,090	8,563	666,245	1,039,483	1.56	1,393	180
Randolph	350,436	24,284	4,492	379,262	602,390	1.59	830	236
Ray	177,061	25,469	2,654	205,184	389,028	1.90	944	132
Vernon	72,936	1,179	1,262	75,377	117,142	1.56	117	223
Other counties[a]	14,082	1,021	.....	15,103	28,288	1.87	42	254
Small mines	.....	90,420	.....	90,420	175,844	1.94	.....	.....
	3,335,527	391,975	84,091	3,811,593	6,595,918	1.73	9,173	186

[a] Livingston, Putnam, and Ralls.

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Coal produced in Missouri, 1912–1915, in net tons.

County.	1912	1913	1914	1915	Increase or decrease, 1915.
Adair	593,067	439,991	256,397	280,187	+ 23,790
Audrain	25,512	10,606	10,360	13,803	+ 3,443
Barton	382,082	495,328	505,282	657,009	+151,787
Bates	159,229	168,469	145,031	71,312	− 73,719
Boone	19,096	15,791	12,514	17,450	+ 4,936
Caldwell, Clay, Dade, Johnson, and Platte	126,652	101,158	110,559	88,964	− 21,595
Callaway	22,962	32,889	39,555	64,136	+ 24,581
Cole, Cooper, and Moniteau	[a] 3,583	3,931	[b] 3,032	[b] 3,350	+ 318
Grundy, Harrison, Schuyler, and Sullivan	134,866	192,932	111,949	[c] 103,881	− 11,068
Henry	143,584	261,196	224,894	183,311	− 41,583
Howard, Montgomery, and Ralls	35,174	26,287	[d] 23,900	(e f)	− 23,900
Lafayette	749,598	729,606	703,029	799,297	+ 96,268
Linn	125,649	117,025	108,626	97,242	− 11,384
Macon	818,170	778,264	765,365	666,245	− 99,120
Putnam	31,710	21,835	10,367	(f)	− 10,367
Randolph	483,903	481,882	424,245	379,282	− 44,963
Ray	375,164	343,235	324,080	205,184	−118,896
Vernon	(f)	10,073	43,165	75,377	+ 32,212
Other counties	[f] 9,840	.....	.....	[f] 15,103	+ 15,103
Small mines	98,815	86,977	110,630	90,420	− 20,210
Total	4,339,856	4,319,125	3,935,980	3,811,593	−124,387
Total value	$7,633,864	$7,468,308	$6,802,325	$6,595,918	−$206,407

[a] No production in Cooper County.
[b] No production in Cole County.
[c] No production in Schuyler County.
[d] No production in Montgomery County.
[e] No production in Howard and Montgomery counties.
[f] Other counties include Livingston and Vernon in 1912, and Livingston, Putnam, and Ralls in 1915.

MONTANA.

The production of coal in Montana in 1915 was 2,789,755 net tons, valued at $4,526,509, a quantity only 15,418 tons, or about one-half of 1 per cent, less than in 1914. The demand for Montana coal for railroad fuel, particularly for coal from the Roundup field in Musselshell County, has been curtailed by the electrification of a portion of the Chicago, Milwaukee & St. Paul Railway, but this was offset during the second half of the year by a good market for coal for domestic and commercial uses. Fergus County showed a large increase, due to a new development equipped with a modern washer at Lehigh, on the Great Northern Railway. Another large mine with tipple and screening plant of the latest design began shipments from the Carpenter Creek district of the Roundup field during the year.

The number of men employed in the coal mines of Montana decreased from 3,350 in 1914 to 3,158 in 1915, and the average number of days decreased from 209 to 201. The average output per man per day was 4.4 tons, and for the year 883 tons, against 4 tons and 837 tons in 1914.

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Coal produced in Montana in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Carbon	1,120,807	26,537	65,597	1,212,941	$2,245,689	$1.85	1,516	206
Cascade	629,263	29,159	6,001	664,423	924,112	1.39	843	187
Fergus	13,838	4,202	5,064	23,104	69,285	3.00	98	177
Hill	2,272	13,934	50	16,256	36,500	2.25	21	234
Musselshell	815,035	8,927	26,078	850,040	1,533,662	1.80	774	248
Other counties [a]	19,472	9,530	1,181	30,183	84,678	2.81	98	167
Small mines	.....	8,226	.....	8,226	19,175	2.33	.....	.....
	2,600,687,	100,515	103,971	2,805,173	4,913,191	1.75	3,350	209

[a] Blaine, Missoula, Park, and Sheridan.

1915.

Carbon	1,068,226	31,575	72,920	1,172,721	$2,137,043	$1.82	1,503	187
Cascade	588,424	25,224	6,097	619,745	900,764	1.45	711	195
Fergus	57,686	3,031	7,645	68,362	96,859	1.42	97	226
Hill	2,521	11,471	125	14,117	34,132	2.42	24	251
Musselshell	841,192	10,083	35,746	887,021	1,297,319	1.46	792	231
Sheridan	3,190	3,366	.....	6,556	12,203	1.86	10	169
Other counties [a]	.....	3,567	59	3,626	10,459	2.88	21	113
Small mines	.....	17,607	.....	17,607	37,730	2.14	.....	.....
	2,561,239	105,924	122,592	2,789,755	4,526,509	1.62	3,158	201

[a] Chouteau, Missoula, and Valley.

Coal produced in Montana, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Carbon	1,185,189	1,187,270	1,304,524	1,212,941	1,172,721	− 40,220
Cascade	994,043	855,576	912,634	664,423	619,745	− 44,678
Chouteau	9,727	21,590	.....	.....	(a)	.....
Fergus	16,711	6,251	5,348	23,104	68,362	+ 45,258
Hill	.....	9,999	9,405	16,256	14,117	− 2,139
Musselshell	706,364	913,904	963,968	850,040	887,021	+ 36,981
Sheridan	.....	.....	.....	(a)	6,556	+ 6,556
Other counties	[b] 59,305	[c] 51,098	[d] 37,896	[e] 30,183	[f] 3,626	− 26,557
Small mines	5,019	2,807	7,198	8,226	17,607	+ 9,381
Total	2,976,358	3,048,495	3,240,973	2,805,173	2,789,755	− 15,418
Total value	$5,342,168	$5,558,195	$5,653,539	$4,913,191	$4,526,509	−$386,682

[a] Included in "Other counties."
[b] Includes Gallatin, Missoula, Park, and Valley counties.
[c] Includes Gallatin, Missoula, Park, Rosebud, and Valley counties.
[d] Includes Blaine, Custer, Missoula, Park, Rosebud, and Valley counties.
[e] Includes Blaine, Missoula, Park, and Sheridan counties.
[f] Includes Chouteau, Missoula, and Valley counties.

NEVADA.

The first production of coal in Nevada of which there is any record was in 1911, a small output having been reported from the Coaldale field in T. 2 N., R. 37 E., in Esmeralda County, in the southwestern part of the State. The production and value for 1911, 1912, and 1913 are included with those of Idaho, and for 1914 and 1915 with those of Idaho and California.

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NEW MEXICO.

The resumption of normal conditions in Colorado following the settlement of the coal-miners' strike at the close of 1914 had a marked effect upon the coal production of New Mexico in 1915, which amounted to 3,817,940 net tons, valued at $5,481,361, and was a decrease, compared with 1914, of 59,749 tons, or nearly 2 per cent, in quantity and of $749,510, or 12 per cent, in value. Although such factors as mild weather and small demand from Mexico for coke are in part responsible for this decrease, the fact that in all counties except Colfax there was increase and that the output of Colfax County decreased nearly 150,000 tons indicates that Colorado fields adjoining that county on the north regained markets which in the strike year, 1914, were supplied by the Raton field in New Mexico, and that this condition contributed largely to the increase in production recorded for New Mexico in 1914, a year when all other States in the Rocky Mountain region suffered decrease.

The number of men employed in 1915 increased from 4,178 to 4,205, but the average number of days worked decreased from 283 to 262 and the average annual output per employee from 928 to 908 tons. The average daily output increased slightly, from 3.28 tons in 1914 to 3.47 tons in 1915. The proportion of the output shot from the solid decreased from 19 per cent in 1914 to 3 per cent in 1915 and that undercut by hand increased from 65 to 80 per cent. The percentage of coal mined by machines (17) was practically the same in both years.

Coal produced in New Mexico in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at the mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Colfax	2,231,944	17,056	23,528	742,835	3,015,363	$4,627,978	$1.53	2,905	299
Santa Fe and Socorro	133,697	1,299	10,578	.....	145,574	435,418	2.99	281	281
McKinley	677,687	10,090	18,954	.....	706,731	1,146,539	1.62	972	237
Rio Arriba and San Juan	4,000	3,450	325	.....	7,775	13,075	1.68	20	202
Small mines	.....	2,246	.....	.....	2,246	7,861	3.50	.....	.....
	3,047,328	34,141	53,385	742,835	3,877,689	6,230,871	1.61	4,178	283

1915.

Colfax	2,115,719	15,210	800	734,713	2,866,442	$3,842,048	$1.34	2,912	264
Lincoln, Santa Fe, and Socorro	140,741	8,053	8,412	.....	157,206	467,422	2.97	286	265
McKinley	759,562	6,272	19,656	.....	785,490	1,158,309	1.47	963	259
Rio Arriba and San Juan	5,060	3,225	.....	.....	8,285	12,755	1.54	24	162
Small mines	.....	517	.....	.....	517	827	1.60	.....	.....
	3,021,082	33,277	28,868	734,713	3,817,940	5,481,361	1.44	4,205	262

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Coal produced in New Mexico, 1912–1915, in net tons.

County.	1912	1913	1914	1915	Increase or decrease, 1915.
Colfax	2,691,306	2,749,765	3,015,363	2,866,442	— 148,921
Lincoln, Santa Fe, and Socorro	105,622	120,129	[a] 145,574	157,206	+ 11,632
McKinley	735,544	824,762	706,731	785,490	+ 78,759
Rio Arriba and San Juan	3,415	11,100	7,775	8,285	+ 510
Small mines	937	3,050	2,246	517	— 1,729
Total	3,536,824	3,708,806	3,877,689	3,817,940	— 59,749
Total value	$5,037,051	$5,401,260	$6,230,871	$5,481,361	— $749,510

[a] Santa Fe and Socorro counties only.

NORTH DAKOTA.

The production of lignite in North Dakota in 1915 amounted to 528,078 net tons, an increase of 21,393 tons, or 4 per cent, compared with 1914. The output in 1915 was valued at $766,072. Practically all the lignite mined in North Dakota is used within the State, and nearly one-half is consumed at the place of production, not even being loaded on railroad cars. The increase in population is followed by greater use of coal, and although lignite, except in the remoter districts, is not largely used for domestic fuel, the industries, such as brick making, that do use lignite, are growing, and with their growth the production of lignite has increased steadily.

There were 590 men employed in the mining of lignite in North Dakota in 1915 for an average of 219 days, compared with 558 men for 216 days in 1914. The average output per man per day was 4 tons and for the year 895 tons, against 4.2 tons per day and 908 tons for the year in 1914.

Lignite produced in North Dakota in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Adams	2,951	8,111	.....	11,062	$17,480	$1.58	14	280
Burke	4,060	7,690	.....	11,750	14,910	1.27	15	247
Hettinger	.....	5,100	.....	5,100	6,474	1.27	7	200
McLean	.....	10,161	.....	10,161	14,797	1.46	14	271
Morton	12,086	21,277	960	34,323	46,672	1.36	41	258
Ward	47,463	15,600	5,094	68,157	121,952	1.79	128	214
Williams	7,258	31,348	144	38,750	59,666	1.54	39	262
Other counties [a]	273,988	15,597	8,884	298,469	442,924	1.48	300	199
Small mines	.....	28,913	.....	28,913	46,504	1.61	.....	.....
	347,806	143,797	15,082	506,685	771,379	1.52	558	216

[a] Billings, Bowman, Burleigh, Divide, Oliver, and Stark.

1915.

Adams	3,223	7,379	25	10,627	$14,946	$1.41	18	281
Burke	4,600	5,400	.....	10,000	12,520	1.25	17	221
Hettinger	.....	4,182	.....	4,182	5,154	1.23	3	328
McLean	1,854	7,841	.....	9,695	14,244	1.47	13	282
Morton	16,000	33,174	850	50,024	68,796	1.38	35	239
Ward	43,576	13,130	4,800	61,506	99,942	1.62	117	242
Williams	3,916	28,529	525	32,970	51,378	1.56	32	259
Other counties [a]	285,453	19,670	11,299	316,422	444,767	1.41	355	199
Small mines	.....	32,652	.....	32,652	54,325	1.66	.....	.....
	358,622	151,957	17,499	528,078	766,072	1.45	590	219

[a] Billings, Bowman, Burleigh, Divide, Dunn, Oliver, and Stark.

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Lignite produced in North Dakota, 1911–1915, in net tons.

County	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Adams	11,860	9,568	9,584	11,062	10,627	— 435
Burke	16,585	11,950	12,175	11,750	10,000	— 1,750
Burleigh	(a)	187,008	194,002	(a)	(a)	.....
Hettinger	.....	11,029	7,550	5,100	4,182	— 918
McLean	7,163	(a)	8,716	10,161	9,695	— 466
Morton	20,084	36,326	40,486	34,323	50,024	+15,701
Stark	58,377	59,785	55,557	(a)	(a)	.....
Ward	138,105	89,274	77,110	68,157	61,506	— 6,651
Williams	20,916	22,953	27,758	38,750	32,970	— 5,780
Other counties	[b] 205,026	[c] 41,161	[d] 45,015	[e] 298,469	[f] 316,422	+17,953
Small mines	24,562	30,426	17,367	28,913	32,652	+ 3,739
Total	502,628	499,480	495,320	506,685	528,078	+21,393
Total value	$720,489	$765,105	$750,652	$771,379	$766,072	—$5,307

[a] Included in "Other counties."
[b] Includes Burleigh, Divide, Hettinger, Mercer, and Oliver counties.
[c] Includes Bowman, Divide, Dunn, McLean, Mercer, and Oliver counties.
[d] Includes Bowman, Divide, Mercer, and Oliver counties.
[e] Includes Billings, Bowman, Burleigh, Divide, Oliver, and Stark counties.
[f] Includes Billings, Bowman, Burleigh, Divide, Dunn, Oliver, and Stark counties.

OHIO.

The coal output of Ohio in 1915 was far below the normal of 30,000,000 tons for that State, but the quantity, 22,434,691 tons, was an increase of 3,591,576 tons, or 19.1 per cent, over 1914, when, because of the disastrous strike, the production fell off about one-half compared with 1913. So severe and long continued were the effects of this strike—not entirely settled even in 1915—that Ohio has with difficulty regained the markets lost through inability to supply coal.

On the northern edge of the Ohio coal fields 6 counties, all with small outputs, showed decreases. The producing territory adjoining the Pittsburgh district of Pennsylvania and westward across the coal area, including what are known as No. 8 and Cambridge districts, showed substantial increase. In the Hocking district Athens County had a large decrease and Perry County a small one; but Hocking County showed a slight gain. Meigs (Pomeroy district), Jackson, and Vinton counties all had greater outputs in 1915 than in 1914, Meigs County recording an increase of nearly 410,000 tons, almost double the production in 1914. The production of Lawrence County, in the extreme southern part of the State, was about 127,000 tons, a decrease compared with 1914. Ohio operators, especially those in the Hocking district, state that they are at a disadvantage, compared with West Virginia, because of unfavorable freight rates, comparatively higher mining rates, and the recognized superiority of the West Virginia coals for steam purposes. In the last few years Hocking coal has lost its position at the head of the Lakes as a steam coal to West Virginia and eastern Kentucky coals. Railroads no longer give preference to Ohio coal and it is reported that the roads using this coal have reduced their consumption by perhaps 30 per cent through economies effected by the use of new mechanical devices for firing. Competition with outside fields for the markets within the State of Ohio is very keen, and Ohio operators are endeavoring to have the intrastate freight rates adjusted in such a manner as to enable them to control the major portions of this market.

The value of the Ohio coal produced in 1915 was $24,207,075, an increase of $2,956,433, or about 14 per cent, compared with 1914. The average value per ton decreased from $1.13 to $1.08, and it is

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therefore evident that the average net return to the operators in 1915 was lower than in 1914.

Although the number of men on strike was much less in 1915 than in 1914—40,577 men for more than 6,400,000 days in 1914, against 15,048 men for about 1,700,000 days in 1915—there was a large decrease in the number of men employed, from 45,401 to 40,053. The average number of days these men worked increased, however, from 108 to 142, and the average number of tons produced daily by each employee likewise increased about 2½ per cent.

Coal produced in Ohio in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Athens	3,142,588	46,776	108,825	.....	3,298,189	$3,682,607	$1.12	6,596	125
Belmont	2,475,157	336,262	37,762	.....	2,849,181	2,901,189	1.02	11,720	57
Carroll	178,473	48,474	8,533	.....	235,480	268,055	1.14	533	155
Columbiana	292,226	40,700	9,440	.....	342,366	416,904	1.22	810	135
Coshocton	118,278	32,894	1,874	.....	153,046	211,733	1.38	566	100
Gallia, Morgan, and Scioto	199,729	2,027	6,168	.....	207,924	221,114	1.06	413	135
Guernsey	2,823,801	42,804	70,102	.....	2,936,707	2,953,506	1.01	4,355	152
Harrison	168,455	11,289	5,148	.....	184,892	201,426	1.09	862	60
Hocking	1,135,997	65,437	29,906	.....	1,231,340	1,382,360	1.12	2,301	138
Holmes	.....	8,934	.....	.....	8,934	13,065	1.46	21	260
Jackson	407,166	100,403	25,262	.....	532,831	834,092	1.57	1,645	126
Jefferson	1,817,355	312,430	42,665	431	2,172,881	2,453,846	1.13	5,762	100
Lawrence	119,736	39,491	850	.....	160,077	202,753	1.27	377	166
Mahoning	7,000	8,684	219	.....	15,903	27,746	1.74	56	172
Medina, Portage, and Summit	82,306	25,421	17,336	.....	125,063	257,955	2.06	355	114
Meigs	479,492	43,716	11,576	.....	534,784	593,409	1.11	1,067	143
Muskingum	269,820	56,765	1,744	.....	328,329	369,113	1.12	676	149
Noble	487,305	7,492	7,145	.....	501,942	502,718	1.00	842	136
Perry	1,098,549	52,330	35,795	.....	1,186,674	1,309,810	1.10	3,204	110
Stark	292,170	143,784	21,979	.....	457,933	721,754	1.58	879	178
Tuscarawas	708,485	188,533	24,218	.....	921,236	1,039,467	1.13	1,803	136
Vinton	24,907	56,929	2,536	.....	84,372	99,839	1.18	258	114
Wayne	68,462	4,458	15,425	.....	88,345	206,685	2.34	280	118
Small mines	.....	284,686	.....	.....	284,686	379,496	1.33	.....	.....
	16,397,457	1,960,719	484,508	431	18,843,115	21,250,642	1.13	45,401	108

1915.

Athens	2,404,428	41,200	74,860	.....	2,520,488	$2,689,132	$1.07	6,519	106
Belmont	3,947,808	313,737	43,021	.....	4,304,566	4,287,878	.99	8,202	114
Carroll	291,386	48,780	4,800	.....	344,966	391,985	1.14	563	236
Columbiana	490,476	40,661	10,725	.....	541,862	619,237	1.14	812	208
Coshocton	163,976	30,709	3,749	.....	198,434	249,880	1.26	490	145
Gallia, Morgan, and Scioto	101,593	1,762	6,025	.....	109,380	113,273	1.04	217	50
Guernsey	3,135,367	19,480	78,114	.....	3,232,961	3,211,007	.99	4,213	168
Harrison	199,134	11,053	4,443	.....	214,630	222,013	1.03	768	78
Hocking	1,161,249	79,421	23,859	.....	1,264,529	1,347,619	1.07	2,076	162
Holmes	.....	6,117	.....	.....	6,117	8,278	1.35	17	264
Jackson	452,422	87,419	25,468	.....	565,309	857,717	1.52	1,654	118
Jefferson	3,215,583	316,824	74,829	1,217	3,608,453	3,845,363	1.07	5,392	151
Lawrence	85,018	41,012	1,343	.....	127,373	145,947	1.15	307	177
Mahoning	6,984	5,172	400	.....	12,556	22,317	1.78	45	168
Medina	.....	5,596	.....	.....	5,596	11,094	1.98	15	197
Meigs	885,136	48,487	10,266	.....	943,889	992,324	1.05	1,550	207
Muskingum	330,281	52,333	4,372	.....	386,986	413,505	1.07	576	192
Noble	580,818	7,897	8,071	.....	596,786	597,179	1.00	751	174
Perry	1,070,159	46,076	20,241	.....	1,136,476	1,191,993	1.05	2,533	127
Portage and Summit	91,322	5,452	12,754	.....	109,528	219,577	2.00	240	140
Stark	206,062	129,993	15,965	.....	352,020	583,478	1.66	829	153
Tuscarawas	1,104,180	230,701	32,654	.....	1,367,535	1,511,632	1.11	1,918	208
Vinton	65,876	35,590	2,338	.....	103,804	117,597	1.13	152	215
Wayne	62,327	4,918	7,404	.....	74,649	147,192	1.97	214	153
Small mines	.....	305,798	.....	.....	305,798	409,858	1.34	.....	.....
	20,051,585	1,916,188	465,701	1,217	22,434,691	24,207,075	1.08	40,053	142

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Coal produced in Ohio, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Athens	4,292,527	4,819,774	4,968,633	3,298,189	2,520,488	− 777,701
Belmont	8,092,127	9,382,330	10,436,259	2,849,181	4,304,566	+1,455,385
Carroll	269,167	322,969	379,064	235,480	344,966	+ 109,486
Columbiana	660,196	448,778	522,804	342,366	541,862	+ 199,496
Coshocton	390,812	371,399	364,411	153,040	198,434	+ 45,388
Gallia, Morgan, and Scioto	190,609	294,860	298,744	207,924	109,380	− 98,544
Guernsey	3,895,682	4,246,955	4,321,992	2,936,707	3,232,961	+ 296,254
Harrison	559,267	812,953	730,221	184,892	214,630	+ 29,738
Hocking	1,576,119	1,763,177	1,678,623	1,231,340	1,264,529	+ 33,189
Holmes	10,930	10,257	8,987	8,934	6,117	− 2,817
Jackson	669,591	737,284	587,044	532,831	565,309	+ 32,478
Jefferson	4,687,731	4,858,529	5,178,922	2,172,881	3,608,453	+1,435,572
Lawrence	59,192	66,158	176,098	160,077	127,373	− 32,704
Mahoning	52,748	33,194	15,786	15,903	12,556	− 3,347
Medina, Portage, and Summit	209,493	[a] 172,079	[a] 158,174	125,063	115,124	− 9,939
Meigs	516,845	644,463	642,725	534,784	943,889	+ 409,105
Muskingum	376,446	435,629	472,748	328,329	386,986	+ 58,657
Noble	472,003	624,404	787,141	501,942	596,786	+ 94,844
Perry	2,086,799	2,145,916	2,177,564	1,186,674	1,136,476	− 50,198
Stark	450,256	414,452	417,238	457,933	352,020	− 105,913
Tuscarawas	677,330	1,324,594	1,419,922	921,236	1,367,535	+ 446,299
Vinton	104,338	97,938	122,492	84,372	103,804	+ 19,432
Wayne	209,059	194,036	97,233	88,345	74,649	− 13,696
Small mines	250,719	276,599	237,702	284,686	305,798	+ 21,112
Total	30,759,986	34,528,727	36,200,527	18,843,115	22,434,691	+3,591,576
Total value	$31,810,123	$37,083,363	$39,948,058	$21,250,642	$24,207,075	+$2,956,433

[a] Includes Trumbull County.

OKLAHOMA.

The production of coal in Oklahoma in 1915 amounted to 3,693,580 net tons, valued at $7,435,906, a decrease of 295,033 tons, or 7 per cent, in quantity and of $768,109, or 9 per cent, in value compared with 1914.

The markets for Oklahoma coal in the South were effected by the cotton congestion in the early months of the year and by the increasing use of fuel oil and natural gas. The rise in price of crude oil later in the year encouraged the coal operators to expect a widening of their markets and increased business. All counties except Latimer had decreased output in 1915.

The number of men employed increased from 8,078 in 1914 to 8,457 in 1915 and the average days worked declined from 205 to 167.

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Coal produced in Oklahoma in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Coal	633,593	11,128	31,571	676,292	$1,486,371	$2.20	1,537	236
Latimer	606,446	4,394	55,434	666,274	1,338,194	2.01	1,217	200
Le Flore	248,446	3,916	11,661	264,023	436,729	1.65	469	214
Okmulgee	890,445	1,731	12,952	905,128	1,584,872	1.75	1,576	211
Pittsburg	1,227,512	12,881	133,378	1,373,771	3,155,357	2.30	3,024	186
Other counties [a]	94,055	3,755	550	98,360	189,458	1.92	255	201
Small mines	.....	4,765	.....	4,765	13,034	2.74	.....	.....
	3,700,497	42,570	245,546	3,988,613	8,204,015	2.06	8,078	205

[a] Rogers, Tulsa, and Wagoner.

1915.

Coal	527,833	8,800	19,846	556,479	$1,225,281	$2.20	1,663	161
Latimer	620,715	6,746	113,408	740,869	1,373,126	1.85	1,274	198
Le Flore	240,797	3,003	12,842	256,642	409,818	1.60	550	182
Okmulgee	857,256	1,394	10,594	869,244	1,496,601	1.72	1,690	157
Pittsburg	1,037,219	6,285	88,768	1,132,272	2,661,618	2.35	2,961	159
Tulsa	93,693	1,537	930	96,160	182,914	1.90	195	225
Other counties [a]	16,987	3,287	669	20,943	43,248	2.07	69	119
Small mines [b]	12,033	8,430	508	20,971	43,300	2.06	55	45
	3,406,533	39,482	247,565	3,693,580	7,435,906	2.01	8,457	167

[a] Rogers and Wagoner. [b] Includes Atoka County.

Coal produced in Oklahoma in 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Coal	778,546	816,155	889,299	676,292	556,479	— 119,813
Haskell and Latimer	701,374	766,798	738,679	[a] 666,274	[a] 740,869	+ 74,595
Le Flore	122,468	150,511	201,853	264,023	256,642	— 7,381
Okmulgee	408,202	629,969	820,659	905,128	869,244	— 35,884
Pittsburg	1,018,742	1,234,334	1,429,350	1,373,771	1,132,272	— 241,499
Rogers and Wagoner	18,784	30,126	31,067	.....	20,943	— 77,417
Tulsa	21,422	39,964	52,300	(b)	96,160	+ 96,160
Small mines	[c] 4,704	[d] 7,541	2,563	[c] 4,765	[d] 20,971	+ 16,206
Total	3,074,242	3,675,418	4,165,770	3,988,613	3,693,580	— 295,033
Total value	$6,291,494	$7,867,331	$8,542,748	$8,204,015	$7,435,906	—$768,109

[a] Latimer County only.
[b] Included with small mines.
[c] Includes Atoka and Johnston counties.
[d] Includes Atoka County.
[e] Includes Tulsa County.

OREGON.

The production of coal in Oregon in 1915 was 39,231 net tons, valued at $111,240, a decrease, compared with 1914, of 12,327 tons, or 24 per cent, in quantity and of $32,316, or 23 per cent, in value.

The only developed coal field in Oregon is in the Coos Bay district, on the Pacific coast. The only outlet at present for the coal is by boat, but the completion of the projected line of the Southern Pacific Co. from Eugene to Marshfield will enable the Coos Bay output to reach wider markets. At present wood is largely used for domestic

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fuel in this territory and wood and oil are the principal fuels in the industries. The Coos Bay coal is subbituminous and can not be used to any extent for bunkering. In view of these conditions no great progress is to be expected in Oregon coal production.

Coal produced in Oregon, 1911–1915.

Year.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
1911	22,407	10,216	14,038	46,661	$108,033	$2.32	189	179
1912	14,361	19,646	7,630	41,637	106,276	2.60	222	239
1913	31,582	8,617	5,864	46,063	116,724	2.53	203	283
1914	37,152	5,798	8,608	51,558	143,556	2.78	190	266
1915	30,142	2,272	6,817	39,231	111,240	2.84	151	206

PENNSYLVANIA.

PENNSYLVANIA ANTHRACITE.

PRODUCTION.

The production of anthracite in Pennsylvania in 1915, including that from Sullivan County, the washery product obtained from culm banks, and that dredged from rivers, was 79,459,876 gross tons, valued at $184,653,498. Anthracite is used mainly as a domestic fuel, and the mild weather during the early months of 1915, a falling off in exports to Canada, and very light buying by householders and retailers during the summer period of low prices all contributed to a decrease from the output in 1914. The production in 1914 was 81,090,631 tons, valued at $188,181,399, so that the decrease in 1915 was 1,630,755 tons, or 2 per cent, in quantity, and $3,527,901, or nearly 2 per cent, in value. The average value, $2.32 a ton at the mines, was practically the same in the two years and has been exceeded in only two years, 1912 and 1913.

Of the total production in 1915 (79,459,876 tons), 68,666,456 tons, or 87 per cent, was shipped outside the producing region, 1,867,934 tons, or 2 per cent, was consumed locally, and 8,925,486 tons, or 11 per cent, was used at the mines, breakers, washeries, and dredges for steam and heat.

The coal consumed in the producing region, including that used by employees and others, consists largely of the small sizes, and that used in the collieries consists entirely of the very smallest and least valuable product. Of the total shipments 41,098,355 tons, or 60 per cent, consisted of broken, egg, stove, and nut sizes, and 26,929,824 tons, or 39 per cent, the sizes known as pea, buckwheat, rice, and barley. Although originally considered steam coal, pea and to a smaller extent buckwheat have gone into domestic trade, and the pea size is now generally known in the larger eastern cities as "the poor man's anthracite." It is no longer sold at the mines below the cost of production, as the smaller sizes are, but at $1 to $1.65 a ton less than the so-called domestic sizes. Furthermore, pea coal is

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carried at a lower freight rate than some of the larger sizes, so that not uncommonly it retails in the East at as much as $2 a ton less. It is thus apparent that a large portion of the cost of mining was borne by and practically all the profit derived from 52 per cent of the total production—that is, from the prepared sizes larger than pea.

Of the total shipments in 1915, 66,173,817 tons, or 96 per cent, consisted of freshly mined coal, and 2,492,639 tons, or 4 per cent, of "secondary" product—that is, coal recovered from culm banks or dredged from rivers. Nearly all the secondary coal was in pea and smaller sizes.

The number of men employed in the production and preparation of anthracite in 1915 was 176,552, compared with 179,679 in 1914, and the average number of days these men worked was 230, compared with 245 in 1914. The smaller number of days worked, together with the comparatively large number of men, indicates that, in order to assist all employees, the work during the slack months was divided among a greater number of men than was actually necessary. The average daily output per man was 1.96 tons, the highest since 1908, with the result that there was but a slight decrease in the yearly output per man—from 451 tons in 1914 to 450 in 1915—despite the fewer days worked. As in 1914, there were few strikes, only 30,325 men having been affected for an average of seven days each. In view of the comparative slackness of operations the total time lost by strikes, 214,691 days, can hardly be said to have been an appreciable economic loss or to have affected the production in any way.

In the underground mining of anthracite 148 machines were used in 1915, and on the surface 57 steam shovels were used in uncovering and mining anthracite and in handling the culm from banks for washeries. The total quantity taken from strip pits and culm banks with steam shovels was 1,001,431 tons. The mining machines were used in the northern or Wyoming region, and the steam shovels in the southern or Lehigh and Schuylkill regions. This is the first year that statistics of machine and steam-shovel mining have been collected by the Geological Survey, and it is therefore impossible to make comparisons with previous years. It is evident, however, that a very much smaller proportion of coal is mined by machines in the anthracite region than in the bituminous coal fields, and that the steam shovels play a larger part in mining hard coal than soft.

A total of 139 companies and individuals reported the production of anthracite in 1915. There were 258 breakers, 46 culm-bank washeries, and 26 river dredges in operation during the year. Two of the breakers had an output of more than 1,000,000 tons each, and 33 between 500,000 and 1,000,000 tons each; the production of these 35 breakers represented 32 per cent of the total. The 130 breakers whose output ranged from 200,000 to 500,000 tons each, furnished 57 per cent of the total, and the 93 breakers having an output of less than 200,000 tons each furnished 11 per cent of the total.

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Anthracite produced in 1914 and 1915.

1914.

County.	Quantity (gross tons).				Value.		Number of men employed.	Average number of days worked.
	Shipped.	Sold to local trade and employees.	Used at mines for steam and heat.	Total quantity.	Total.	Average per ton.		
Carbon	2,661,565	25,190	355,529	3,042,284	$6,063,821	$2.19	6,139	255
Columbia	773,635	20,988	143,367	937,990	2,080,308	2.22	1,946	215
Dauphin	651,043	85,235	223,194	959,472	2,088,755	2.17	2,501	245
Lackawanna	17,716,583	522,100	1,737,942	19,976,625	48,386,068	2.42	45,756	248
Luzerne	28,346,586	858,952	3,132,174	32,337,712	75,229,771	2.33	60,742	250
Northumberland	5,127,454	139,802	729,865	5,997,121	14,129,779	2.36	15,227	235
Schuylkill	14,156,231	247,714	2,291,161	16,695,106	37,323,562	2.24	38,718	236
Sullivan	516,689	8,889	49,950	575,528	1,031,962	1.79	1,066	229
Susquehanna and Wayne	514,260	10,663	43,870	568,793	1,261,373	2.22	1,584	272
	70,464,046	1,919,533	8,707,052	81,090,631	188,181,399	2.32	179,679	245

1915.

Carbon	2,641,581	24,582	378,879	3,045,042	6,707,243	2.20	5,798	250
Columbia	872,979	23,286	150,288	1,046,553	2,287,913	2.19	1,900	226
Dauphin	639,223	53,842	255,729	948,794	1,924,168	2.03	2,524	226
Lackawanna	17,575,637	479,306	1,727,802	19,782,745	46,137,560	2.33	44,640	231
Luzerne	26,993,211	890,881	3,151,442	31,035,534	75,996,913	2.35	66,144	235
Northumberland	4,748,596	134,259	784,340	5,667,195	13,137,428	2.32	14,970	211
Schuylkill	14,169,437	230,770	2,389,026	16,789,233	36,135,532	2.15	38,070	223
Sullivan	486,982	9,221	44,200	540,403	1,005,624	1.86	1,057	220
Berks, Lancaster, Montour, Susquehanna, and Wayne	538,810	21,787	43,780	604,377	1,321,117	2.19	1,449	263
	68,666,456	1,867,034	8,925,486	79,459,876	184,653,498	2.32	176,552	230

Anthracite produced in 1890–1915.

Year.	Quantity (gross tons).	Value.	Year.	Quantity. (gross tons).	Value.
1890	41,489,858	[a] $66,383,772	1911	80,771,488	$175,189,392
1895	51,785,122	[a] 82,019,272	1912	75,322,855	177,622,626
1900	51,221,353	[a] 85,757,851	1913	81,718,680	195,181,127
1905	69,339,152	[a] 141,879,000	1914	81,090,631	188,181,399
1910	75,433,246	160,275,302	1915	79,459,876	184,653,498

[a] Excludes value of coal used at collieries.

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SHIPMENTS.

Anthracite is shipped to nearly every State in the Union and to many foreign countries. The major portion is consumed in the territory near Pennsylvania, including Canada. In the larger eastern cities its use has become a necessity, but farther west and south anthracite is more of a luxury than a necessity, and in the States most remote from the East the quantity consumed is small.

The output of the anthracite mines is carefully crushed, cleaned, and divided into sizes by a process and at a cost that render it little less than a manufactured product. There are 10 of these sizes, each with its price and special use. Two major divisions are recognized, however—the prepared or domestic sizes, including broken, egg, stove, and chestnut, which range from 4 inches down to three-fourths of an inch, and the steam coal, including pea, buckwheat, buckwheat No. 2 (rice), and buckwheat No. 3 (barley), which range from three-fourths to one-sixteenth of an inch. The domestic sizes are in greatest demand and consequently bring the highest prices. Attention in preparation is therefore directed to obtaining the largest possible proportion of those sizes, and the finer coal resulting from the crushing is a by-product. It is not possible, however, to increase the proportion of domestic sizes beyond 60 to 65 per cent of the coal shipped, or 50 to 55 per cent of the total product.

The anthracite recovered from culm banks and by dredges from rivers is mainly small coal and represents but a minor portion of the total output.

The anthracite area of Pennsylvania, for which the statistics of production are given by the Geological Survey, includes Sullivan County and the three trade regions, Schuylkill, Lehigh, and Wyoming, embracing parts of nine counties. A small quantity of anthracite, recovered by dredges from rivers outside of these counties, is also included in the total production. There are no dredges in the Lehigh region and no dredges nor washeries in Sullivan County.

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Anthracite shipped in 1914 and 1915, by counties, in gross tons.

1914.

County.	Lump and steamboat.	Broken.	Egg.	Stove.	Chestnut.	Pea.	Buckwheat No. 1.	Buckwheat No. 2 (rice).	Buckwheat No. 3 (barley).	Screenings.	Total.
Carbon	17,416	246,908	337,848	441,747	491,621	343,369	372,386	277,429	132,208	638	2,661,565
Columbia	903	6,842	97,497	168,549	188,207	97,357	131,422	75,976	6,882	.....	773,635
Dauphin	.....	28,819	49,403	119,344	113,464	63,598	120,783	91,155	63,683	794	651,043
Lackawanna	8,533	496,351	2,201,098	3,854,857	4,276,308	2,085,379	2,090,757	839,997	1,810,145	53,158	17,716,583
Luzerne	3,417	1,743,231	3,693,425	6,242,676	6,908,139	3,074,262	3,287,217	1,527,417	1,732,421	54,381	28,346,586
Northumberland	8,492	183,837	531,103	1,036,637	1,193,671	607,275	903,040	571,330	79,994	12,075	5,127,454
Schuylkill	61,755	819,590	1,722,195	2,441,672	2,842,513	1,871,504	2,495,925	1,211,798	612,023	77,256	14,156,231
Sullivan	.....	8,655	47,154	73,364	94,871	69,519	.....	.....	.....	223,126	516,689
Susquehanna and Wayne	.....	12,884	39,086	126,656	116,098	65,356	58,258	27,287	68,635	.....	514,260
	180,516	3,547,117	8,718,809	14,505,502	16,224,892	8,277,619	9,459,788	4,622,389	4,505,986	421,428	70,464,046
Per cent of total	0.3	5.0	12.4	20.6	23.0	11.7	13.4	6.6	6.4	0.6	100.0

1915.

County.	Lump and steamboat.	Broken.	Egg.	Stove.	Chestnut.	Pea.	Buckwheat No. 1.	Buckwheat No. 2 (rice).	Buckwheat No. 3 (barley).	Screenings.	Total.
Carbon	1,630	171,281	297,870	428,672	525,789	355,794	369,470	273,114	215,107	2,854	2,641,581
Columbia	11,131	16,390	96,194	167,810	217,219	118,246	138,049	73,878	30,617	4,445	872,979
Dauphin	.....	26,791	48,059	99,332	103,993	52,498	121,801	106,132	80,617	.....	639,223
Lackawanna	4,168	568,102	2,065,236	3,680,455	4,089,824	2,108,082	2,108,833	1,672,494	1,234,595	43,848	17,575,837
Luzerne	48,111	1,688,217	3,383,200	5,997,099	6,580,672	2,937,730	3,204,214	1,683,853	1,373,623	96,492	26,993,211
Northumberland	23	131,888	455,686	987,840	1,044,593	587,512	827,553	541,627	155,534	16,340	4,748,596
Schuylkill	50,285	733,958	1,684,749	2,494,592	2,786,191	1,925,730	2,494,980	1,155,711	692,321	150,920	14,169,437
Sullivan	.....	13,306	44,971	72,100	90,299	58,276	.....	.....	.....	208,030	486,982
Susquehanna and Wayne	.....	.....	42,375	133,169	131,433	66,800	57,633	53,689	53,711	.....	538,810
	115,348	3,349,933	8,117,340	14,061,069	15,570,013	8,210,668	9,322,533	5,560,498	3,836,125	522,929	68,666,456
Per cent of total	0.2	4.9	11.8	20.4	22.7	11.9	13.6	8.1	5.6	0.8	100.0

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Anthracite shipped in 1914 and 1915, by regions and sizes, in gross tons.

1914.

Size.	Lehigh region.		Schuylkill region.		Wyoming region.		Sullivan County.	Total.
	From mines.	From washeries.	From mines.	From washeries and dredges.	From mines.	From washeries and dredges.	From mines.	
Lump	30,837	.....	69,787	.....	79,892	.....	.....	180,516
Broken	528,801	.....	929,388	.....	2,080,273	.....	8,655	3,547,117
Egg	1,314,414	65	2,107,015	.....	5,250,161	.....	47,154	8,718,809
Stove	1,934,915	6,451	3,400,734	.....	9,089,838	400	73,364	14,505,502
Chestnut	2,089,832	37,857	3,851,564	4,052	10,131,250	15,466	94,871	16,224,892
Pea	1,250,563	37,545	2,314,080	19,178	4,508,667	78,067	69,519	8,277,619
Buckwheat No. 1	1,454,834	38,384	3,232,667	44,562	4,489,484	199,857	.....	9,459,788
Buckwheat No. 2	980,295	51,207	1,634,504	103,715	1,551,024	301,644	.....	4,622,389
Buckwheat No. 3	428,631	67,117	511,657	103,805	2,810,240	584,536	.....	4,505,986
Screenings	20,560	.....	66,330	23,548	68,749	19,115	223,126	421,428
	10,033,682	238,626	18,117,726	298,860	40,059,378	1,199,085	516,689	70,464,046

1915.

Size.	Lehigh region.		Schuylkill region.		Wyoming region.		Sullivan County.	Total.
	From mines.	From washeries.	From mines.	From washeries and dredges.	From mines.	From washeries and dredges.	From mines.	
Lump	7,789	.....	60,057	.....	47,502	.....	.....	115,348
Broken	489,714	.....	786,538	.....	2,060,375	.....	13,306	3,349,933
Egg	1,249,187	.....	1,999,061	288	4,823,813	.....	44,971	8,117,340
Stove	1,884,537	2,399	3,326,849	6,749	8,768,426	9	72,100	14,061,069
Chestnut	2,028,881	31,037	3,644,953	24,521	9,727,135	23,187	90,299	15,570,013
Pea	1,295,741	43,162	2,288,264	65,606	4,369,653	89,966	58,276	8,210,668
Buckwheat No. 1	1,420,566	42,144	3,069,620	135,001	4,446,574	208,628	.....	9,322,533
Buckwheat No. 2	938,954	58,255	1,495,395	168,027	2,337,437	562,430	.....	5,560,498
Buckwheat No. 3	568,230	71,282	608,578	193,321	1,678,336	716,378	.....	3,836,125
Screenings	58,543	.....	135,754	35,107	70,353	15,142	206,030	522,929
	9,942,142	248,279	17,415,089	628,620	38,329,604	1,615,740	486,982	68,666,456

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Anthracite shipped in 1914 and 1915, by sizes, in gross tons.

	1914			1915		
	From mines.	From washeries and dredges.	Total.	From mines.	From washeries and dredges.	Total.
Lump and steamboat	180,516	.....	180,516	115,348	.....	115,348
Broken	3,547,117	.....	3,547,117	3,349,933	.....	3,349,933
Egg	8,718,744	65	8,718,809	8,117,052	288	8,117,340
Stove	14,498,651	6,851	14,505,502	14,051,912	9,157	14,061,069
Chestnut	16,167,517	57,375	16,224,892	15,491,268	78,745	15,570,013
Pea	8,142,829	134,790	8,277,619	8,011,934	198,734	8,210,668
Buckwheat No. 1	9,176,985	282,803	9,459,788	8,936,760	385,773	9,322,533
Buckwheat No. 2 (rice)	4,165,823	456,566	4,622,389	4,771,786	788,712	5,560,498
Buckwheat No. 3 (barley)	3,750,528	755,458	4,505,986	2,855,144	980,981	3,836,125
Screenings	378,765	42,663	421,428	472,680	50,249	522,929
	68,727,475	1,736,571	70,464,046	66,173,817	2,492,639	68,666,456

The statistics of shipments show the quantities of anthracite transported out of the region, but do not represent current consumption, for the reason that the principal companies maintain large stocks, to which is added the excess of production over demand in slack months and from which supplies are drawn when demand exceeds supply from the mines. The storage piles are at places distant from the mines and near main points of consumption, so that shipments reported from the anthracite region may go directly to the consumer, to the retailers' yards, or to storage. The Anthracite Bureau of Information publishes monthly statements of shipments, exclusive of the Sullivan County and dredge product, and these figures show the rate of production during the year. It will be noted from the following table, made up from that source, that shipments during April to September, inclusive, are usually in excess of those during the winter months. Although anthracite is consumed mainly during the winter, the practice of the operators of reducing the price on domestic sizes from April to August has encouraged purchases during that period for winter use, and furthermore, the necessity of taking advantage of the open season of navigation for transporting the product to the head of the Great Lakes for the winter supply of the Northwest has tended to even up the production throughout the year. In general also the operators add to the storage piles in the summer and draw from them in the winter.

In 1914 the summer percentage of the shipments shown in this table was 52; in 1915 it was but 50.5.

Anthracite shipped in 1911–1915, by months, in gross tons.

Month.	1911	1912	1913	1914	1915
January	5,904,117	5,763,606	6,336,419	5,175,732	4,734,535
February	5,070,948	5,875,968	5,674,169	4,121,451	4,275,107
March	5,996,894	6,569,687	4,909,288	5,164,703	4,985,398
April	5,804,915	266,625	5,966,189	6,072,164	6,486,201
May	6,317,352	1,429,357	5,995,742	6,281,553	5,797,961
June	6,215,357	6,191,646	5,970,047	6,130,186	5,316,102
July	4,804,065	6,285,153	5,487,852	5,301,857	4,934,206
August	5,531,796	6,576,591	5,369,900	5,483,743	5,330,831
September	5,730,935	5,876,496	5,572,279	6,246,192	5,518,771
October	6,269,179	6,665,321	6,338,194	6,644,476	6,505,892
November	6,193,314	6,165,536	5,786,931	5,928,286	6,297,215
December	6,115,427	5,944,502	5,662,618	5,702,258	5,939,844
	69,954,299	63,610,578	69,069,628	68,342,601	66,122,062

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PRICES.

The leading companies issue monthly statements of "circular prices," which form the basis on which the product is to a large extent bought or sold. Since 1901 it has been their practice to reduce the price on domestic sizes 50 cents a ton below the circular rate in April and make advances from the reduced price of 10 cents a ton each month during the summer, until in September the circular price is again reached. This practice encourages retailers and consumers to buy and store coal during the summer. The circular prices for the last five years for the coals known as Mahanoy, Shenandoah, Locust Mountain, and Schuylkill white ash are given in the following table. The figures for rice and barley are the quotations of the Lehigh Coal & Navigation Co.; the others are those of the Philadelphia & Reading Coal & Iron Co.'s circular.

Circular prices per gross ton for anthracite at the mines, 1911–1915.

Size.	1911	1912	1913	1914	1915	Size.	1911	1912	1913	1914	1915
Lump	$3.50	$3.50	$3.50	$3.50	$3.50	Chestnut [a]	$4.00	$4.15	$4.15	$4.15	$4.15
Steamboat	3.00	3.00	3.00	3.50	3.50	Pea	2.00	2.50	2.50	2.50	2.50
Broken furnace [a]	3.50	3.50	3.50	3.50	3.50	Buckwheat	1.50	1.50	1.50	1.50	1.50
Egg [a]	3.75	3.75	3.75	3.75	3.75	Rice	.538	.634	.654	1.05	1.05
Stove [a]	3.75	4.00	4.00	4.00	4.00	Barley	.339	.388	.402	.55	.55

[a] Subject to 50 cents reduction in April, 40 cents in May, 30 cents in June, 20 cents in July, and 10 cents in August, except in 1912, when discounts were omitted during April and May.

Circular prices per gross ton for free-burning white-ash anthracite f. o. b. New York Harbor ports and Port Richmond (Philadelphia) in 1914 and 1915. [a]

Size.	New York Harbor.		Port Richmond.		Size.	New York Harbor.		Port Richmond.	
	1914	1915	1914	1915		1914	1915	1914	1915
Broken [b]	$5.00	$5.00	$4.75	$4.75	Buckwheat:				
Egg [b]	5.25	5.25	5.00	5.00	No. 1	$2.45	$2.45	$2.27	$2.25
Stove [b]	5.25	5.25	5.00	5.00	No. 2	1.95	1.92	1.72	1.71
Chestnut [b]	5.50	5.50	5.25	5.25	No. 3	1.58	1.57	1.39	1.41
Pea	3.35	3.34	3.24	3.19					

[a] Philadelphia & Reading Coal & Iron Co.'s circular through chestnut size. Remainder of sizes are average prices f. o. b. by same company.
[b] Subject to 50 cents reduction in April, 40 cents in May, 30 cents in June, 20 cents in July, and 10 cents in August.

The only changes to be noted are the lower prices for the smaller sizes, buckwheat Nos. 1, 2, and 3, which were sold at slightly lower figures in 1915 than in previous years.

As before stated, the "circular" is the basis on which sales are negotiated, and only under normal conditions does it represent the prices at which the product changes hands. The larger part of the anthracite product is sold on contract and at prices, varying with the condition of the market, that may be either above or below the circular prices. In furnishing statistics to the Geological Survey, operators give the total returns received for their product, to which they add an estimate of the value of the anthracite used at the mines for steam and heat. The average value shown in this report is the total value divided by the total number of tons produced. That a portion of the production was sold below the circular prices is indi-

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cated by the fact that the average value, calculated on the basis of these prices and taking into account the quantities of the various sizes and the proportion marketed during the discount months, April to August, as shown in the foregoing tables, exceeds that shown by the returns from the operators. The average values in 1914 and 1915, so far as they can be given without disclosing individual figures, are shown in the following table:

Average values, per gross ton, for anthracite produced, 1914 and 1915.

County.	1914				1915			
	Breakers.	Washeries.	Dredges.	Total product.	Breakers.	Washeries.	Dredges.	Total product.
Carbon	$2.25	(a)	.....	$2.19	$2.28	(a)	.....	$2.20
Columbia	2.23	.....	$0.94	2.22	2.20	.....	$0.78	2.19
Dauphin	(a)	(a)	.96	2.17	(a)	(a)	.73	2.03
Lackawanna	2.49	$1.00	(a)	2.42	2.44	$0.70	.....	2.33
Luzerne	2.37	.77	(a)	2.33	2.51	.82	(a)	2.45
Northumberland	2.37	(a)	.98	2.36	2.33	(a)	.85	2.32
Schuylkill	2.26	.98	1.05	2.24	2.15	1.01	.87	2.15
Sullivan	1.79	.....	.....	1.79	1.86	.....	.....	1.86
Other counties[b]	2.21	.....	.....	2.21	2.21	.....	1.27	2.19
Average	2.37	.90	1.00	2.32	2.39	.82	.82	2.32

[a] Included in "Total product."
[b] Susquehanna and Wayne 1914; Berks, Lancaster, Montour, Susquehanna and Wayne, 1915.

It should be emphasized that the values given in the foregoing table are averages obtained by dividing the total returns to the operators by total output. The total returns are made up of sales at prices per ton ranging from around half a dollar or less for screenings to more than $4 for chestnut.

A tabular statement of the several sections of the anthracite fields is given in the following table:

Anthracite coal fields.

Field and local district.	Trade region.	County.
NORTHERN.		
Carbondale	Wyoming	Lackawanna.
Scranton		Susquehanna.
Pittston		Wayne.
Wilkes-Barre		
Plymouth		
Kingston		
EASTERN MIDDLE.		Luzerne.
Green Mountain	Lehigh	Carbon.
Black Creek		
Hazleton		
Beaver Meadow		
Panther Creek		
SOUTHERN.		Schuylkill.
East Schuylkill	Schuylkill	Columbia.
Western Schuylkill		Dauphin.
Lorberry		Northumberland.
Lykens Valley		
WESTERN MIDDLE.		
East Mahanoy		
West Mahanoy		
Shamokin		

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The anthracite fields are reached by 11 so-called initial railroads, as follows:

Central Railroad of New Jersey.
Delaware & Hudson Railroad.
Delaware, Lackawanna & Western Railroad.
Erie Railroad.
Lehigh & New England Railroad.
Lehigh Valley Railroad.
New York, Ontario & Western Railway.
New York, Susquehanna & Western Railroad (part of Erie system).
Northern Central Railroad (part of Pennsylvania system).
Pennsylvania Railroad.
Philadelphia & Reading Railway.

PENNSYLVANIA BITUMINOUS COAL.

The production of bituminous coal in Pennsylvania in 1915 amounted to 157,955,137 net tons, valued at $167,419,705, an increase compared with 1914, of 9,971,843 tons, or 6.7 per cent, in quantity and of $8,413,409, or 5.3 per cent, in value. The increase was general, only 5 counties out of 23, whose production is recorded separately, having decreased in output, and of these 5, only 2, Clarion and Jefferson, produce more than a million tons annually.

In the beginning of the year the bituminous business was in a depressed condition, for the collapse of the iron and steel industries and the general slowness of other lines of manufacture were attended by reduced activity among the railroads and resulted in little demand for bituminous coal. Producers of coal, both large and small, anxious to keep their organizations together, were actively competing for business, and the effect on the market was severe. Contracts taken during the first half of the year were on a basis unsatisfactory to the operators and at prices reported by many of them as below cost of production. A gradual improvement in business began in May and continued through the summer, but the full strength of the prosperity was not realized until September. In September and October the demand overtook the supply, and in November and December the shortage in cars so hindered deliveries that coal prices rose to a high point. Unfortunately for the operators, most of the supply that could be furnished was required to fill contracts previously made, and the larger companies were unable to take advantage of the spot market. Scarcity of labor was also evident, but the restriction on output because of inadequate car supply prevented that factor from becoming acute.

Returns from the operators of both beehive and by-product coke plants show that the quantity of coal made into coke in Pennsylvania, practically all of which originated in the State, was 8,000,000 tons, or 27 per cent, greater in 1915 than in 1914, which accounts for about 80 per cent of the total increase for the State. More than one-half the total increase was in Fayette County.

The number of men employed in the production of coal in Pennsylvania in 1915 was 174,593, nearly 10,000 less than in 1914; the average days worked increased from 214 to 226.

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Bituminous coal produced in Pennsylvania in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Allegheny	15,901,295	634,679	270,203	2,045	16,808,202	$18,951,940	$1.13	22,326	206
Armstrong	4,374,737	65,530	139,122	.....	4,579,389	4,777,354	1.04	6,904	192
Beaver	55,497	43,562	2,750	.....	101,809	129,889	1.28	394	112
Bedford	452,523	11,812	10,701	159,183	634,219	648,582	1.02	1,078	205
Blair	287,856	244	8,223	12,622	308,945	392,380	1.27	610	178
Bradford and Lycoming	26,451	8,930	993	.....	36,374	61,227	1.68	90	203
Butler	938,979	18,358	24,367	.....	981,704	1,019,680	1.04	1,412	210
Cambria	15,795,841	1,008,859	324,967	904,820	18,034,487	20,153,882	1.12	25,025	221
Cameron and McKean	32,545	7,601	392	.....	40,538	52,669	1.30	87	238
Center	1,242,084	20,019	1,972	.....	1,264,075	1,331,250	1.05	1,820	211
Clarion	1,302,789	15,161	23,442	.....	1,341,392	1,409,030	1.05	2,016	229
Clearfield	6,450,522	220,213	200,642	277,646	7,149,023	7,491,977	1.05	10,872	208
Clinton	309,747	15,914	884	.....	326,545	451,643	1.38	438	225
Elk	896,475	37,581	29,182	.....	963,238	1,013,558	1.05	1,579	211
Fayette	6,073,058	234,887	574,886	16,453,349	23,336,180	24,495,859	1.05	22,926	225
Greene	208,911	6,989	20,270	54,327	290,497	314,637	1.08	339	271
Huntingdon	793,074	6,449	16,171	35,434	851,128	1,025,434	1.20	1,362	230
Indiana	9,006,512	63,608	208,923	143,863	9,422,906	9,583,267	1.02	12,766	199
Jefferson	3,945,278	61,402	151,142	931,801	5,089,623	5,355,815	1.05	6,194	207
Lawrence	109,060	3,940	10,987	.....	123,987	159,716	1.29	212	280
Mercer	666,655	8,446	41,804	.....	716,995	889,288	1.24	1,216	211
Somerset	9,913,973	68,746	256,044	.....	10,238,763	11,281,008	1.10	11,709	236
Tioga	638,320	32,384	8,517	.....	679,221	1,111,421	1.64	1,729	162
Washington	14,375,346	149,338	382,493	588,497	15,495,674	17,073,814	1.10	22,351	194
Westmoreland	21,079,387	618,995	674,844	6,622,201	28,995,427	29,638,435	1.02	28,686	231
Small mines	.....	172,863	.....	.....	172,863	192,541	1.11	.....	.....
	114,876,895	3,536,600	3,384,011	26,185,788	147,983,294	159,006,296	1.07	184,201	214

1915.

Allegheny	16,519,220	636,638	259,595	2,362	17,417,815	$18,855,348	$1.08	20,478	221
Armstrong	4,939,692	64,416	155,774	.....	5,159,882	5,209,589	1.01	6,337	202
Beaver	61,075	25,476	1,340	.....	87,891	119,736	1.36	153	222
Bedford	489,416	12,331	6,828	127,216	635,791	683,258	1.07	883	218
Blair	287,873	341	8,725	11,602	308,541	379,325	1.23	497	190
Bradford and Lycoming	39,870	9,323	1,711	.....	50,904	89,388	1.76	99	243
Butler	977,645	34,825	24,407	.....	1,036,877	1,112,187	1.07	1,514	204
Cambria	16,430,421	891,570	312,048	1,082,412	18,716,451	21,755,913	1.16	23,072	223
Cameron and McKean	37,684	9,014	313	.....	47,011	64,555	1.37	82	260
Center	1,402,648	21,458	6,643	.....	1,430,749	1,444,473	1.01	1,902	217
Clarion	1,260,717	9,532	20,870	.....	1,291,119	1,326,430	1.03	1,737	214
Clearfield	7,210,091	164,158	243,170	405,475	8,022,894	8,543,730	1.06	11,309	218
Clinton	346,166	10,776	2,333	.....	359,275	447,434	1.25	406	222
Elk	995,687	36,063	13,804	.....	1,045,554	1,155,692	1.11	1,657	219
Fayette	6,905,608	225,839	537,992	20,754,628	28,424,067	29,297,580	1.03	24,427	260
Greene	470,635	5,004	23,509	46,860	546,008	612,039	1.12	514	281
Huntingdon	936,096	6,968	19,648	48,038	1,010,750	1,307,728	1.29	1,445	258
Indiana	9,174,284	52,565	183,750	143,258	9,553,857	9,509,221	.99	11,129	208
Jefferson	3,722,927	46,069	146,212	980,201	4,895,409	5,202,517	1.06	5,989	217
Lawrence	119,475	2,609	9,662	.....	131,746	171,157	1.30	229	268
Mercer	656,209	6,285	31,917	.....	694,411	833,255	1.20	1,083	228
Somerset	10,016,230	102,115	225,024	.....	10,343,369	11,581,969	1.12	11,198	230
Tioga	753,017	26,564	8,422	.....	788,003	1,254,624	1.59	1,708	196
Washington	14,634,678	108,934	297,657	857,450	15,898,719	16,681,842	1.05	20,019	205
Westmoreland	20,788,979	557,553	507,161	8,038,868	29,892,561	29,598,539	.99	26,726	236
Small mines	.....	165,483	.....	.....	165,483	182,176	1.10	.....	.....
	119,176,343	3,231,909	3,048,515	32,498,370	157,955,137	167,419,705	1.06	174,593	226

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Bituminous coal produced in Pennsylvania, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Allegheny	17,863,795	18,867,265	20,117,823	16,808,202	17,417,815	+ 609,613
Armstrong	3,799,227	4,104,989	5,321,622	4,579,389	5,159,882	+ 580,493
Beaver	203,556	247,465	248,585	101,809	87,891	— 13,918
Bedford	528,170	731,477	850,792	634,219	635,791	+ 1,572
Blair	294,048	324,336	391,717	308,945	308,541	— 404
Bradford and Lycoming	(a)	(b)	(c)	36,374	50,904	+ 14,530
Butler	957,074	1,000,947	1,080,002	981,704	1,036,877	+ 55,173
Cambria	16,928,628	17,585,130	19,621,378	18,034,487	18,716,451	+ 681,964
Cameron and McKean	(a)	54,394	48,942	40,538	47,011	+ 6,473
Center	1,140,263	1,291,374	1,497,271	1,264,075	1,430,749	+ 166,674
Clarion	1,057,390	1,199,322	1,427,848	1,341,392	1,291,119	— 50,273
Clearfield	7,852,426	7,938,337	8,278,015	7,149,023	8,022,894	+ 873,871
Clinton	314,643	345,454	343,054	326,545	359,275	+ 32,730
Elk	1,223,856	1,146,496	1,201,065	963,238	1,045,554	+ 82,316
Fayette	26,610,162	32,366,567	32,607,963	23,336,180	28,424,067	+ 5,087,887
Greene	31,743	35,839	316,752	290,497	546,008	+ 255,511
Huntingdon	806,199	834,914	935,774	851,128	1,010,750	+ 159,622
Indiana	8,780,983	9,174,927	10,204,684	9,422,996	9,553,857	+ 130,861
Jefferson	5,550,816	5,416,536	5,801,864	5,089,623	4,895,409	— 194,214
Lawrence	90,151	75,823	94,283	123,987	131,746	+ 7,759
Mercer	859,355	846,228	777,601	716,995	694,411	— 22,584
Somerset	9,177,421	9,888,144	9,928,776	10,238,763	10,343,369	+ 104,606
Tioga	830,330	997,787	943,748	679,221	788,003	+ 108,782
Washington	15,343,772	16,645,127	18,309,317	15,495,674	15,898,719	+ 403,045
Westmoreland	24,102,195	30,589,549	33,258,702	28,995,427	29,892,561	+ 897,134
Small mines	a 215,054	b 157,061	c 173,639	172,863	165,483	— 7,380
Total	144,561,257	161,865,488	173,781,217	147,983,294	157,955,137	+ 9,971,843
Total value	$146,154,952	$169,370,497	$193,039,806	$159,006,296	$167,419,705	+$8,413,409

a Small mines include Bradford, Cameron, Lycoming, and McKean counties.
b Small mines include Fulton and Lycoming counties; no production in Bradford county.
c Small mines include Lycoming County; no production in Bradford County.

SOUTH DAKOTA.

A small quantity of lignite, amounting to 10,593 net tons, valued at $16,384, was mined in the lignite area of northwestern South Dakota in 1915. The output in 1915 was 1,257 tons, or 11 per cent, less in quantity and $4,072, or 20 per cent, less in value than the output in 1914.

All of the lignite mined in South Dakota was used locally, about two-thirds of the quantity in the immediate neighborhood of the mines and the remainder after transportation by rail for short distances.

Lignite produced in South Dakota in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Dewey and Harding	4,274	868	5,142	$7,271	$1.41	14	179
Meade	.....	625	625	2,400	3.84	9	128
Perkins	.....	6,083	6,083	10,785	1.77	24	145
	4,274	7,576	11,850	20,456	1.73	47	152

1915.

Dewey and Harding	3,794	1,851	5,645	$7,476	$1.32	12	203
Meade	.....	400	400	1,485	3.71	4	93
Perkins	.....	4,548	4,548	7,423	1.63	19	138
	3,794	6,799	10,593	16,384	1.55	35	155

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Lignite produced in South Dakota in 1913–1915, in net tons.

County.	1913	1914	1915	Increase or decrease, 1915
Dewey and Harding	1,040	5,142	5,645	+ 503
Meade	575	625	400	— 225
Perkins	8,925	6,083	4,548	— 1,535
Total	10,540	11,850	10,593	— 1,257
Total value	$20,648	$20,456	$16,384	—$4,072

TENNESSEE.

The production of coal in Tennessee in 1915 was 5,730,361 net tons, valued at $6,479,916, a decrease of 212,897 tons, or 3.6 per cent, compared with that in 1914. The decrease in value was $296,657, or 4.4 per cent. All of the more important counties showed decrease. The number of men employed decreased from 10,116 in 1914 to 8,948 in 1915. The average number of days worked was 220 in both years.

The coal fields of Tennessee are so hedged about by competing districts, in some of which the cost of mining is much lower, that it is with difficulty that the Tennessee operators are able to hold their old markets, and of course under these conditions new markets of any extent are not attainable except for some of the particularly high-grade coals. During the last six years the developments in the coal fields of southeastern Kentucky and Virginia on the north and northeast, and of Alabama on the south, have curtailed the markets for Tennessee coal, and the production in 1915 was the lowest since 1904 and nearly 1,400,000 tons less than in 1910, the banner year for that State.

Coal produced in Tennessee in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Anderson	560,934	7,978	10,707	.....	579,619	$615,429	$1.06	892	187
Campbell	1,611,843	22,005	41,673	.....	1,675,521	2,080,823	1.24	3,276	210
Claiborne	1,345,045	3,873	22,134	.....	1,371,052	1,414,112	1.03	1,331	246
Marion	519,413	5,921	6,332	6,499	538,165	673,880	1.25	1,112	238
Morgan	325,639	2,749	13,835	29,574	371,797	389,899	1.05	782	247
Scott	60,260	2,914	3,000	.....	75,174	90,976	1.21	218	224
Other counties [a]	1,017,940	11,899	57,042	240,989	1,327,870	1,504,643	1.13	2,505	220
Small mines	.....	4,060	.....	.....	4,060	6,811	1.68	.....	.....
	5,450,074	61,399	154,723	277,062	5,943,258	6,776,573	1.14	10,116	220

1915.

Anderson	489,695	5,737	15,090	.....	510,522	$537,246	$1.05	709	173
Campbell	1,597,076	19,387	47,245	.....	1,663,708	2,023,656	1.22	2,839	214
Claiborne	1,105,845	10,407	24,890	.....	1,141,142	1,171,513	1.03	1,167	221
Fentress	248,104	4,165	7,718	.....	259,987	261,266	1.00	387	278
Grundy	262,275	1,102	1,220	41,215	305,812	327,279	1.07	599	225
Marion	467,373	5,831	5,930	.....	479,134	653,608	1.36	915	216
Morgan	308,867	2,144	13,341	47,054	371,406	352,842	.95	567	227
Other counties [a]	696,357	16,905	52,126	227,869	993,257	1,143,789	1.15	1,765	223
Small mines	.....	5,393	.....	.....	5,393	8,717	1.62	.....	.....
	5,175,592	71,071	167,560	316,138	5,730,361	6,479,916	1.13	8,948	220

[a] Bledsoe, Fentress, Grundy, Hamilton, Overton, Rhea, Roane, Sequatchie, and White.
[b] Bledsoe, Hamilton, Overton, Rhea, Roane, Scott, Sequatchie, and White.

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Coal produced in Tennessee, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Anderson	735,135	542,467	659,345	579,619	510,522	− 69,097
Bledsoe, Rhea, Roane, Sequatchie, and White	[a] 894,778	[b] 946,169	[b] 867,879	[c] 1,327,870	[d] 993,257	− 334,613
Campbell	1,703,666	1,763,918	1,779,338	1,675,521	1,663,708	− 11,813
Claiborne	1,287,708	1,251,650	1,456,468	1,371,052	1,141,142	− 229,910
Fentress	(e)	(e)	(e)	(e)	259,987	+ 259,987
Grundy	284,040	290,589	319,736	(e)	305,812	+ 305,812
Hamilton	365,131	395,843	366,545	(e)	(e)	.....
Marion	517,116	651,030	677,505	538,165	479,134	− 59,031
Morgan	458,097	427,256	497,484	371,797	371,406	− 391
Overton	75,669	57,472	86,165	(e)	(e)	.....
Scott	128,728	145,131	146,063	75,174	(e)	− 75,174
Small mines	3,088	1,703	3,636	4,060	5,393	+ 1,333
Total	6,433,156	6,473,228	6,860,184	5,943,258	5,730,361	− 212,897
Total value	$7,209,734	$7,379,903	$7,839,721	$6,776,573	$6,479,916	−$296,657

[a] Includes Cumberland, Fentress, and Franklin counties.
[b] Includes Cumberland and Fentress counties.
[c] Includes Fentress, Grundy, Hamilton, and Overton counties.
[d] Includes Hamilton, Overton, and Scott counties.
[e] Included with Bledsoe and other counties.

TEXAS.

The output of coal in Texas in 1915 was 2,088,908 net tons, valued at $3,445,487, a decrease of 234,865 tons, or 10 per cent, in quantity and of $476,972, or 12 per cent, in value. The production of both lignite and bituminous coal decreased. Coal mined in Texas competes with fuel oil and natural gas and also with coal from Alabama and from New Mexico and Colorado, and the increased use of fuel oil and natural gas has had the effect of decreasing the demand for coal in this region.

The coal mines in Texas (49 operating in 1915) are scattered over a wide area and the production by counties can not be published without revealing individual returns. It is the practice of the Geological Survey, therefore, to show the combined figures for lignite and for bituminous coal.

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Coal produced in Texas in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Bituminous: Eastland, Erath, Maverick, Palo Pinto, Webb, Wise, Young	1,179,698	7,299	31,163	1,218,160	$2,881,453	$2.37	3,031	246
Lignite: Bastrop, Fayette, Henderson, Hopkins, Houston, Lee, Leon, Medina, Milam, Robertson, Titus, Wood	1,068,075	4,004	33,534	1,105,613	1,041,006	.94	1,604	220
	2,247,773	11,303	64,697	2,323,773	3,922,459	1.69	4,635	237

1915.

Bituminous: Eastland, Erath, Maverick, Palo Pinto, Webb, Wise, Young	1,155,964	9,656	32,172	1,197,792	$2,715,393	$2.27	3,680	241
Lignite: Bastrop, Fayette, Henderson, Hopkins, Houston, Lee, Leon, Medina, Milam, Robertson, Titus, Wood	860,322	3,610	27,184	891,116	730,094	.82	1,407	210
	2,016,286	13,266	59,356	2,088,908	3,445,487	1.65	5,087	233

UTAH.

The production of coal in Utah in 1915 amounted to 3,108,715 net tons, valued at $4,916,916, an increase of 5,679 tons in quantity and a decrease of $18,538 in value. The principal gains were in Emery and Grand counties and there was a small increase in Carbon County. The production of Summit and Uinta counties decreased more than 30,000 tons. Although consumption by railroads was below normal, and mild weather curtailed domestic sales, the increased activity in the metal-mining and smelting industries brought the production for the year up to that of 1914.

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The number of employees decreased from 4,112 in 1914 to 3,564 in 1915, and the average number of days worked decreased from 210 to 208. The average annual output of coal per employee increased, however, from 755 to 872 tons and the average output per day from 3.6 to 4.2 tons, a high average. Machine mining has increased greatly in Utah in recent years, the returns showing that in 1913 20 per cent, in 1914, 30 per cent, and in 1915, 50 per cent of the total production was mined by that method.

Coal produced in Utah in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Carbon	1,950,149	30,046	85,905	603,411	2,669,511	$4,224,726	$1.58	3,516	214
Emery and Grand	345,920	5,198	6,650	.....	357,768	592,114	1.66	452	198
Summit	59,618	444	8,084	.....	68,146	100,371	1.47	131	162
Uinta	.....	4,779	100	.....	4,879	11,309	2.32	13	266
Small mines	.....	2,732	.....	.....	2,732	6,934	2.54	.....	.....
	2,355,687	43,199	100,739	603,411	3,103,036	4,935,454	1.59	4,112	210

1915.

Crabon	1,896,257	28,324	92,087	654,387	2,671,055	$4,212,559	$1.58	2,842	200
Emery and Grand	375,544	6,552	7,984	.....	390,080	617,268	1.58	657	246
Summit and Uinta	30,999	7,445	4,233	.....	42,677	76,162	1.78	65	175
Small mines	.....	4,903	.....	.....	4,903	10,927	2.23	.....	.....
	2,302,800	47,224	104,304	654,387	3,108,715	4,916,916	1.58	3,564	208

Coal produced in Utah, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Carbon	2,264,038	2,684,731	2,830,102	2,669,511	2,671,055	+ 1,544
Emery	[a] 120,256	[b] 212,818	[c] 314,915	[b] 357,768	390,080	+ 32,312
Summit	126,228	114,657	108,027	73,025	42,677	− 30,348
Uinta						
Small mines	2,653	3,943	1,784	2,732	4,903	+ 2,171
Total	2,513,175	3,016,149	3,254,828	3,103,036	3,108,715	+ 5,679
Total value	$4,248,666	$5,046,451	$5,384,127	$4,935,454	$4,916,916	−$18,538

[a] Includes Sanpete County. [b] Includes Grand County. [c] Includes Grand and Sevier counties.

VIRGINIA.

The production of coal in Virginia in 1915 was 8,122,596 net tons, valued at $7,962,934, an increase, compared with 1914, of 163,061 tons, or 2 per cent, in quantity, but a decrease of $69,514, or less than 1 per cent, in value. With the exception of the "banner year," 1913, when the production was more than 8,800,000 tons, the output in

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1915 was the highest recorded for Virginia. Wise County, the largest producer, showed a decrease of more than 400,000 tons, but all the other counties recorded increases.

The coal shipped to market, including that sold to railroads, increased more than 500,000 tons, but the quantity made into coke was less in 1915 by 330,000 tons than in 1914.

During the early months of the year coal mining was inactive, but in August the demand for both coal and coke became stronger, and by the end of the year the production was reported up to capacity and limited only by shortage of labor and cars. The completion of the Southern Railway's modern coal-loading pier at the port of Charleston, S. C., and the establishment of rates and port charges for coal from southwestern Virginia equal to those for coal from the Pocahontas field of West Virginia to Hampton Roads piers gave an additional impetus to production in that part of the State.

The number of men employed decreased from 9,183 in 1914 to 8,959 in 1915, but the average number of days for each man, 235, was the same in both years. The average number of tons produced per man during 1915 was 907, compared with 867 in 1914, and the average output per man per day increased from 3.69 to 3.86 tons. The proportion of coal mined by hand decreased from 18 to 3 per cent, and the proportion mined by machines increased from 51 to 63 per cent. The quantity of washed coal increased from 54,971 tons in 1914 to 178,525 tons in 1915.

Coal produced in Virginia in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Lee	708,072	6,557	18,306	.....	732,935	$800,835	$1.09	1,005	251
Russell	1,198,267	13,450	24,397	.....	1,236,114	1,276,828	1.03	1,515	244
Tazewell	1,169,997	23,380	20,823	109,330	1,323,530	1,520,065	1.15	1,144	179
Wise	3,325,156	34,949	77,804	1,182,793	4,620,702	4,345,204	.94	5,396	242
Other counties [a] and small mines	36,641	6,013	3,600	.....	46,254	89,496	1.93	123	245
	6,438,133	84,349	144,930	1,292,123	7,959,535	8,032,448	1.01	9,183	235

1915.

Lee	719,927	6,323	16,061	.....	742,311	$778,861	$1.05	953	248
Russell	1,456,403	14,804	22,214	.....	1,493,421	1,351,469	.90	1,526	243
Tazewell	1,480,816	23,932	20,641	121,692	1,647,081	1,844,383	1.12	1,427	198
Wise	3,251,443	28,023	72,183	834,660	4,186,309	3,874,099	.93	4,864	240
Other counties [a] and small mines	39,646	9,128	4,700	.....	53,474	114,122	2.13	189	251
	6,948,235	82,210	135,799	956,352	8,122,596	7,962,934	.98	8,959	235

[a] Montgomery and Pulaski.

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Coal produced in Virginia, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Lee	720,695	751,276	763,315	732,935	742,311	+ 9,376
Montgomery and Pulaski	(a)	(a)	(a)	45,151	51,141	+ 5,990
Russell	[b] 1,107,056	[b] 1,292,365	[b] 1,512,356	1,236,114	1,493,421	+257,307
Tazewell	1,281,224	1,302,043	1,447,351	1,323,530	1,647,081	+323,551
Wise	3,754,360	4,500,174	5,103,559	4,620,702	4,186,309	—434,393
Small mines	1,332	780	1,487	1,103	2,333	+ 1,230
Total	6,864,667	7,846,638	8,828,068	7,959,535	8,122,596	+163,061
Total value	$6,254,804	$7,518,576	$8,962,653	$8,032,448	$7,962,934	—$69,514

[a] Included with Russell County. [b] Includes Henrico, Montgomery, and Pulaski.

WASHINGTON.

The production of coal in Washington in 1915 amounted to 2,429,095 net tons, valued at $5,276,299, a decrease compared with 1914 of 635,725 tons, or 21 per cent, in quantity and of $1,475,212, or 22 per cent, in value. All of the principal producing counties shared in the decrease.

The falling off in output of coal is attributed to several factors, the most potent of which is the inability of coal to meet the competition with California fuel oil as a source of power. The railroads in recent years have adopted oil-burning locomotives; many of the older industrial plants have substituted oil for coal; and most of the new industrial plants install oil-burning equipment. The removal of the duty on coal has allowed increasing quantities of Canadian coal to enter the Washington markets, coal from Vancouver Island now being used extensively in the Puget Sound cities and British Columbian coal from the Crows Nest district entering the Spokane district. The bunker trade has fallen off since the war began, and the number of vessels entering the Sound ports has decreased. This is offset to some extent by vessels having westbound cargoes above normal now taking on fuel coal in Washington (or Vancouver, British Columbia) ports rather than carrying sufficient Japanese coal for the round trip. A material betterment in the lumber market, the principal industry of the Northwest, will of course benefit the coal producers.

Coal produced in Washington in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
King	939,471	41,836	60,473	.....	1,041,780	$2,153,702	$2.07	2,390	177
Kittitas	1,181,342	16,322	45,136	.....	1,242,800	2,851,882	2.29	1,828	186
Lewis	82,171	16,090	5,659	.....	103,860	168,021	1.62	211	128
Pierce	388,411	4,739	40,107	123,262	556,519	1,384,185	2.49	1,230	239
Thurston and Whatcom	114,946	904	4,011	.....	119,861	193,721	1.62	146	166
	2,706,341	79,831	155,386	123,262	3,064,820	6,751,511	2.20	5,805	191

1915.

King	762,081	34,014	54,000	.....	850,095	$1,623,592	$1.91	1,834	157
Kittitas	831,101	13,955	34,336	.....	879,392	2,092,689	2.38	1,530	126
Lewis	64,225	11,777	4,886	.....	80,888	136,959	1.69	177	127
Pierce	315,867	3,783	28,693	149,290	497,633	1,232,076	2.48	1,198	248
Thurston and Whatcom	115,777	1,178	4,132	.....	121,087	190,983	1.58	116	166
	2,089,051	64,707	126,047	149,290	2,429,095	5,276,299	2.17	4,850	160

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Coal produced in Washington, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
King	1,259,521	1,063,110	1,373,699	1,041,780	850,095	− 191,685
Kittitas	1,256,745	1,237,427	1,334,155	1,242,800	879,392	− 363,408
Lewis	172,734	128,377	151,446	103,360	80,388	− 22,972
Pierce	783,196	788,293	856,425	556,519	497,633	− 58,886
Thurston and Whatcom	100,619	143,725	162,166	119,861	121,087	+ 1,226
Total	3,572,815	3,360,932	3,877,891	3,064,820	2,429,095	− 635,725
Total value	$8,174,170	$8,042,871	$9,243,137	$6,751,511	$5,276,299	−$1,475,212

WEST VIRGINIA.

The output of coal in West Virginia in 1915 was the greatest on record and amounted to 77,184,069 net tons, valued at $74,561,349, an increase, compared with 1914, of 5,476,443 tons, or nearly 8 per cent, in quantity and of $3,169,941, or more than 4 per cent, in value, and was more than double the production in 1904, 12 years before. The greatest increase was in the New River and Pocahontas fields, embracing Fayette, McDowell, Mercer, and Raleigh counties; and Logan County, in the southwestern part of the State, and Tucker County, in the northern part, also made notable increase. The increase was in the commercial coal shipped to market, as the quantities made into coke within the State, that used locally near the mines, and that used by the mines for steam and heat all decreased. Increased shipments to tidewater for export, to the Great Lakes for cargo, and to the Middle West for by-product coking, as well as that sold for railroad fuel and general commercial use, all contributed to swell the total.

The coal industry of West Virginia was in a depressed condition during the early months of 1915. In fact, it is understood that the production in the 12 months ended June 30, 1915, was the lowest that had been recorded for a similar period for many years. Improvement began about May, and production increased rapidly without setback until November. In November, and more particularly in December, shortage in cars, and to a less extent, in labor, began to be felt in parts of the State, curtailing production somewhat at the end of the year. The high rate of production attained during the last half of 1915 has been continued in 1916, and unless a setback is encountered a new record will be established.

The shortage in labor is indicated by the labor statistics, which show that the number of men employed in the production of coal in West Virginia decreased from 78,963 in 1914 to 75,882 in 1915. The increased output was attained, however, by an increase in the average number of working days (201 in 1914 and 208 in 1915) and by an increased daily average output per employee (4.52 net tons in 1914 and 4.89 in 1915), which resulted in an increase in the average annual production per man from 908 tons in 1914 to 1,017 tons in 1915.

The increased output in 1915 was not obtained by the operators without some sacrifice, for the average value at the mines per net ton decreased 2 per cent, from 99 to 97 cents, and the total value for the State increased by 4.4 per cent, compared with an increase in output of 7.6 per cent. Of the counties which had notable increase, Tucker was the only one showing an increased average value per ton for the coal produced.

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Coal produced in West Virginia in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Made into coke at mines (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Barbour	1,275,330	5,566	19,831	31,221	1,331,948	$1,063,552	$0.80	1,316	203
Boone	576,489	8,065	8,004	.....	592,558	594,061	1.00	704	171
Braxton	300,826	2,152	3,630	.....	306,608	245,630	.80	277	229
Brooke	537,318	12,153	5,399	.....	554,870	608,745	1.10	981	235
Clay	551,915	3,039	8,607	.....	563,561	462,922	.82	439	238
Fayette	8,267,536	143,873	218,017	409,312	9,038,738	9,776,601	1.08	12,956	198
Gilmer	109,036	3,612	2,228	.....	114,876	108,538	.94	141	202
Grant	167,018	1,705	10,919	.....	179,642	157,046	.87	218	229
Harrison	5,212,449	10,042	45,146	24,026	5,291,683	4,327,962	.82	5,088	187
Kanawha	5,835,189	63,978	89,888	.....	5,989,055	5,759,916	.96	8,245	191
Logan	6,493,140	43,261	82,353	197	6,618,951	6,113,808	.92	5,474	195
McDowell	13,193,032	208,888	241,379	945,265	14,588,564	15,786,010	1.08	14,495	185
Marion	6,411,663	30,013	211,521	78,345	6,731,542	6,057,525	.90	6,526	210
Marshall	957,428	174,113	21,585	.....	1,153,126	1,183,862	1.03	1,076	276
Mason	104,362	15,469	2,080	.....	121,911	127,897	1.05	230	226
Mercer	2,627,554	32,374	48,125	253,088	2,961,141	3,173,931	1.07	3,022	183
Mineral	625,765	2,475	5,166	.....	633,406	580,207	.92	999	187
Mingo	2,741,156	30,472	67,386	.....	2,839,014	2,889,069	1.02	3,074	236
Monongalia	256,725	16,145	2,393	139,558	414,821	335,379	.81	418	208
Ohio	497,332	71,670	1,345	.....	570,347	602,135	1.06	536	289
Preston	1,038,870	13,919	37,188	150,673	1,240,650	1,106,744	.89	1,550	216
Putnam	521,491	13,428	9,940	.....	544,859	666,298	1.22	1,190	219
Raleigh	5,297,210	67,231	89,615	.....	5,454,059	6,126,534	1.12	5,986	207
Randolph	355,884	8,395	10,591	145,490	520,360	425,928	.82	505	176
Taylor	1,237,748	4,978	11,378	54,600	1,308,704	1,013,575	.77	1,274	216
Tucker	1,442,402	14,673	34,229	12,911	1,504,215	1,538,019	1.02	1,597	247
Upshur	108,608	2,537	1,512	7,100	119,757	85,533	.71	128	211
Wyoming	72,771	2,287	.....	.....	75,058	86,078	1.15	108	148
Other counties [a]	207,942	49,716	3,350	4,656	265,664	295,100	1.13	410	229
Small mines	.....	77,938	.....	.....	77,938	92,783	1.19	.....	.....
	67,024,189	1,134,170	1,292,825	2,256,442	71,707,626	71,391,408	.99	78,963	201

1915.

Barbour	1,256,903	5,716	21,748	35,702	1,320,069	$1,009,586	$0.76	1,126	216
Boone	644,967	9,592	7,339	.....	661,898	616,705	.93	808	159
Brooke	600,080	10,703	4,663	.....	615,446	650,834	1.06	864	203
Clay	573,515	3,886	6,804	.....	584,205	514,751	.88	384	261
Fayette	9,628,482	146,713	159,871	247,892	10,182,958	10,632,401	1.04	12,159	226
Gilmer	142,220	2,461	3,444	.....	148,125	124,589	.84	125	208
Grant	211,027	678	4,230	.....	215,935	185,988	.86	220	255
Hancock	.....	4,934	.....	.....	4,934	6,615	1.34	8	158
Harrison	5,021,284	17,359	36,786	36,732	5,112,161	4,182,162	.82	4,383	189
Kanawha	5,184,964	65,272	54,988	.....	5,305,224	4,986,328	.94	7,096	161
Lincoln	37,008	7,448	500	.....	44,956	42,627	.95	165	87
Logan	7,786,860	60,313	71,790	.....	7,918,963	6,485,664	.82	6,372	185
McDowell	16,029,494	171,576	262,361	948,008	17,411,439	18,341,530	1.05	14,979	212
Marion	6,357,384	22,366	195,503	114,460	6,689,713	5,807,544	.87	5,488	235
Marshall	798,996	164,939	27,025	.....	990,960	1,018,931	1.03	1,122	251
Mason	105,525	15,119	2,135	.....	122,779	126,942	1.03	196	246
Mercer	3,229,190	32,764	36,624	190,471	3,489,049	3,724,704	1.07	3,181	223
Mineral	662,808	2,098	5,344	.....	660,250	609,378	.92	888	215
Mingo	2,781,277	28,337	62,125	.....	2,871,739	2,727,377	.95	3,276	200
Monongalia	290,920	11,731	1,469	96,102	400,222	335,193	.84	392	181
Ohio	513,350	62,188	1,329	.....	576,867	581,898	1.01	500	254
Preston	1,034,283	19,746	35,328	150,257	1,239,614	999,434	.81	1,258	225
Putnam	533,683	5,442	8,544	.....	547,669	630,611	1.15	1,041	224
Raleigh	5,722,777	94,441	66,267	.....	5,883,485	6,314,558	1.07	5,505	215
Randolph	312,753	7,361	10,465	121,117	451,696	366,968	.81	370	160
Taylor	1,022,612	4,393	14,065	27,534	1,068,594	788,826	.74	1,121	175
Tucker	1,587,732	15,172	30,457	18,206	1,651,567	1,756,940	1.06	1,639	255
Upshur	85,015	2,763	1,802	8,567	98,147	67,849	.69	97	203
Wyoming	240,476	3,231	28	.....	243,735	271,165	1.11	456	158
Other counties [b]	570,656	6,393	8,144	231	585,424	545,136	.93	663	226
Small mines	.....	86,246	.....	.....	86,246	108,115	1.25	.....	.....
	72,956,241	1,091,871	1,141,178	1,995,279	77,184,069	74,561,349	.97	75,882	208

[a] Greenbrier, Hancock, Lewis, Lincoln, Nicholas, Wayne, and Webster.
[b] Braxton, Greenbrier, Lewis, Nicholas, Wayne, and Webster.

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Coal produced in West Virginia, 1911–1915, in net tons.

County.	1911	1912	1913	1914	1915	Increase or decrease, 1915.
Barbour	1,024,784	1,163,361	1,415,301	1,331,948	1,320,069	− 11,879
Boone	160,523	379,976	445,856	592,558	661,898	+ 69,340
Braxton	209,167	234,988	282,517	306,608	(a)	— 306,608
Brooke	451,430	494,471	(a)	554,870	615,446	+ 60,576
Clay	146,713	212,125	371,296	563,561	584,205	+ 20,644
Fayette	9,976,784	9,636,220	9,944,027	9,038,738	10,182,958	+1,144,220
Gilmer	53,580	76,735	93,337	114,876	148,125	+ 33,249
Grant	(a)	(a)	223,045	179,642	215,935	+ 36,293
Greenbrier, Hancock, Lewis, Nicholas, Wayne, and Webster	b 531,384	c 522,706	d 790,285	e 265,664	f 590,358	+ 324,694
Harrison	4,241,098	5,171,772	5,584,437	5,291,683	5,112,161	— 179,522
Kanawha	5,671,026	5,113,557	5,372,953	5,989,055	5,305,224	— 683,831
Lincoln	81,770	(a)	(a)	(a)	44,956	+ 44,956
Logan	3,149,671	4,196,744	4,753,516	6,618,951	7,918,963	+ 1,300,012
McDowell	13,386,749	15,809,289	16,498,447	14,588,564	17,411,439	+ 2,822,875
Marion	4,830,540	5,793,124	6,052,672	6,731,542	6,689,713	— 41,829
Marshall	678,172	798,028	866,049	1,153,126	990,960	— 162,166
Mason	201,943	131,303	148,691	121,911	122,779	+ 868
Mercer	2,924,714	3,109,571	3,317,012	2,961,141	3,489,049	+ 527,908
Mineral	610,727	726,316	851,475	633,406	660,250	+ 26,844
Mingo	2,341,000	2,597,479	2,690,418	2,839,014	2,871,739	+ 32,725
Monongalia	495,657	409,579	394,640	414,821	400,222	— 14,599
Ohio	326,195	412,494	412,640	570,347	576,867	+ 6,520
Preston	870,447	1,167,758	1,331,907	1,240,650	1,239,614	— 1,036
Putnam	568,222	612,066	622,776	544,859	547,669	+ 2,810
Raleigh	4,409,430	5,134,217	5,697,581	5,454,059	5,883,485	+ 429,426
Randolph	553,935	616,410	593,525	520,360	451,696	— 68,664
Taylor	745,578	871,852	1,046,770	1,308,704	1,068,594	— 240,110
Tucker	1,152,116	1,270,578	1,293,489	1,504,215	1,651,567	+ 147,352
Upshur	38,225	59,330	96,822	119,757	98,147	— 21,610
Wyoming	.....	.....	(a)	75,058	243,735	+ 168,677
Small mines	(a)	64,628	62,652	77,938	86,246	+ 8,308
Total	59,831,580	66,786,687	71,254,136	71,707,626	77,184,069	+ 5,476,443
Total value	$53,670,515	$62,792,234	$71,822,804	$71,391,408	$74,561,349	+$3,169,941

a Included with Greenbrier and other counties.
b Includes Grant and Ritchie counties and small mines.
c Includes Grant and Lincoln counties.
d Includes Brooke, Lincoln, and Wyoming counties.
e Includes Lincoln County.
f Includes Braxton County.

WYOMING.

The production of coal in Wyoming in 1915 was 6,554,028 net tons, an increase of 78,735 tons, or more than 1 per cent, compared with 1914. The greatest increase was in the Rock Springs field in Sweetwater County and amounted to more than 122,000 tons. Hot Springs County also had an increase, but all other counties recorded small decreases. The total value of the coal for the State decreased nearly 5 per cent, from $10,033,747 in 1914 to $9,555,804 in 1915.

The increase in the Rock Springs field is attributed to a strong demand for coal by both the railroads and the domestic and steam-coal users during the last half of the year, and to the fact that there were no labor troubles nor lack of railroad cars.

Normally a considerable quantity of Wyoming coal from the Sheridan field reaches market in northern Montana, Idaho, and Washington (in and about Spokane), but Canadian coal now admitted duty free is reported to have partly replaced it and to that cause the decreased production in Sheridan County is partly due. Abundance of water in the Black Hills for the hydroelectric plants cuts off a part of the market for Wyoming coal.

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The number of men employed in the coal mines of Wyoming decreased from 8,117 in 1914 to 7,244 in 1915, but the average number of days worked increased from 192 to 201.

Coal produced in Wyoming in 1914 and 1915.

1914.

County.	Loaded at mines for shipment (net tons).	Sold to local trade and used by employees (net tons).	Used at mines for steam and heat (net tons).	Total quantity (net tons).	Total value.	Average value per ton.	Number of employees.	Average number of days worked.
Carbon and Uinta	636,743	11,750	36,125	684,618	$1,085,478	$1.59	765	225
Converse, Johnson, and Weston	335,986	9,407	19,147	364,540	690,904	1.90	436	200
Fremont, Hot Springs, and Park	376,632	20,789	32,118	429,539	689,384	1.60	510	214
Lincoln	1,367,686	11,016	103,719	1,482,421	2,345,196	1.58	1,886	204
Sheridan	959,775	18,193	23,443	1,001,411	1,202,226	1.20	1,220	157
Sweetwater	2,416,982	13,788	78,601	2,509,371	4,013,648	1.60	3,300	185
Small mines	.....	3,393	.....	3,393	6,911	2.04	.....	.....
	6,093,804	88,336	293,153	6,475,293	10,033,747	1.52	8,117	192

1915.

Carbon and Uinta	626,507	11,903	31,242	669,652	$993,043	$1.48	611	239
Converse, Johnson, and Weston	328,686	6,755	19,633	355,074	669,380	1.88	469	175
Fremont, Hot Springs, and Park	469,918	5,603	22,080	497,601	833,706	1.68	543	205
Lincoln	1,316,653	10,352	89,296	1,416,301	2,145,828	1.52	1,573	233
Sheridan	928,262	12,617	37,744	978,623	1,103,605	1.13	1,157	140
Sweetwater	2,555,185	20,122	56,937	2,632,244	3,799,437	1.44	2,891	203
Small mines	.....	4,533	.....	4,533	10,805	2.38	.....	.....
	6,225,211	71,885	256,932	6,554,028	9,555,804	1.46	7,244	201

Coal produced in Wyoming, 1912–1915, in net tons.

County.	1912	1913	1914	1915	Increase or decrease, 1915.
Carbon and Uinta	1,126,701	682,495	684,618	669,652	− 14,966
Converse, Johnson, and Weston	415,445	371,397	364,540	355,074	− 9,466
Fremont, Hot Springs,[a] and Park	322,747	420,819	429,539	497,601	+ 68,062
Lincoln	1,440,435	1,871,461	1,482,421	1,416,301	− 66,120
Sheridan	1,086,282	1,211,167	1,001,411	978,623	− 22,788
Sweetwater	2,969,601	2,832,475	2,509,371	2,632,244	+ 122,873
Small mines	[b] 6,913	[b] 3,252	3,393	4,533	+ 1,140
Total	7,368,124	7,393,066	6,475,293	6,554,028	+ 78,735
Total value	$11,648,088	$11,510,045	$10,033,747	$9,555,804	−$477,943

[a] Hot Springs County was Big Horn County in 1912.
[b] Includes Crook County.

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COAL—PART B, DISTRIBUTION AND CONSUMPTION.

By C. E. LESHER.

INTRODUCTION.

OBJECT AND SCOPE OF REPORT.

The object of this report is to furnish statistics showing the internal distribution of the coal produced in the United States, the principal purposes for which it is used, and the quantities consumed in each State. For 34 years the Geological Survey has collected and published the statistics of the production and value of coal, but this is the first comprehensive investigation made to show in detail where the coal produced is consumed. The competition between the bituminous coal-producing districts in the United States for the domestic markets is as active as that between the coal-exporting nations of the world for the foreign markets. The extent and nature of the demand in the domestic markets are moveover of ever-present interest to our coal industry, because more than 95 per cent of the coal produced in the United States is used within the country.

The largest problem confronting the exploiters of a coal deposit is, of course, that of markets, and whoever produces or sells the coal must consider in a broad way the possible markets not only as to quantity but as to quality. For blacksmithing and for making coal gas, coals that have special chemical and physical properties are required, and domestic users have established preferences based on both experience and prejudice. By far the largest part of the coal supplied to every market is used for raising steam, and the statistics of coal used for this purpose in any and every part of the country are therefore of primary interest to those who are engaged in the coal industry. The limitations of time and funds available for the work on this report have permitted only incidental consideration of the markets for bituminous coals of particular kinds. The distribution of coal from West Virginia, for instance, is shown for the State as a unit, though there is a great difference between the kinds of coal mined there and as great a difference between the markets reached by the coal.

The cost of mining, the largest element of which—the cost of labor—is now practically controlled either directly or indirectly by the labor unions, and the cost of transportation, regulated by the Government through the Interstate Commerce Commission, impose definite limitations upon the markets that may profitably be reached by any coal. It is fast becoming the rule that the deciding factor in the purchase of coal for most uses is its cost in terms of the work to be performed. The large user of steam coal in Michigan makes

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his contract for coal from Kentucky, Ohio, Pennsylvania, or West Virginia, according to his requirements, after he has determined which coal will evaporate a given quantity of water at the least cost.

The pioneers in the large developments in the eastern Kentucky coal fields within the last few years no doubt took counsel as to the extent and possible future of the markets within reach of that coal, even before they equipped mines and built railroads, and any expectations they may have entertained regarding the possibility of successfully invading the markets of the Great Lakes region appear to have been fully justified. A study of the history of production in eastern Kentucky and of that of the coal fields of Ohio, Pennsylvania, and West Virginia, with which Kentucky comes into competition, would not alone have sufficed, however, to enable them to foretell this. It was equally essential to know the extent to which the different fields were sharing the markets, and whether the consumption of coal in the Lake region was increasing and at what rate.

Statistics of the movement of coal to market are of particular interest to those who are considering railroad rates. The quantity of coal carried by the railroads is larger than that of any other single commodity, and it is the coal traffic that has made possible the profitable operation of a number of important railroads. It is to the interest of the coal-carrying roads, within the limits of fair play, to keep in balance the movement from the competing fields. Here, again, data of the kind given in this report are needed as a basis of intelligent action.

METHOD OF COMPILING AND LIMITS OF ACCURACY IN THE STATISTICS.

Great accuracy can be attained in the statistics of the production of coal, for the reason that the number of producers, though large, is not so great as to prevent a comparatively complete canvass for reports. As the information is obtained at the source of the product the accuracy of the final figures is limited only by the thoroughness of the canvass and the care with which the individual producers have supplied the data. The best source of information on actual consumption is, of course, the consumer, but the attempt to collect such figures from consumers would be little short of that of taking a census of the country—an attempt that obviously can not be made by the Geological Survey. In this investigation data showing the destination of the coal produced were collected from all attainable sources and all the coal that was reported to be shipped to any State was assumed to represent the consumption in that State. As will be shown, this assumption is not necessarily true, but the limitations being recognized, the results may be accepted as showing consumption as closely as it can be ascertained.

The blank forms sent to the operators at the end of 1915 asking for their reports of production requested also a general statement showing the distribution of the product. The replies indicated that most of the smaller operators have no available records giving the destination of their shipments, for the reason that their coal, in part at least, is distributed by the selling agencies of the larger producing companies, by brokers, or by other middlemen. A list of companies

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and individuals engaged in selling and distributing coal was then prepared, and requests were sent to them for information regarding the quantities of coal they handled in 1915 from each producing State, the company or companies that sold them the coal, and the destination of the product. Figures or estimates were also requested covering the several uses for which the coal was sold, namely, (1) domestic and small steam trade, (2) industrial steam trade, (3) coke and coal gas manufacture, (4) railroad fuel, and (5) special uses, as for blacksmithing.

The reports on distribution covered deliveries (1) to tidewater, (2) to the Great Lakes for cargo, (3) to railroads for fuel, and (4) to individual States or to Canada and Mexico by rail. The statistics of the production of each company already available in the Survey afforded a practical check on the reports. Although the statistics furnished by the operators did not show in full the shipments to all individual States, the quantity reported for a number of the States was practically complete.

In order to obtain full statistics of the consumption of coal by railroads, the railroad companies were requested to report the quantity of coal used in 1915 and the States in which the coal was mined. The statistics thus collected are used throughout this report and are discussed in detail on pages 473–474. Statistics of bituminous coal shipped to the Great Lakes for cargo and of fuel coal supplied to vessels on Lake Erie were compiled by the Ohio Bureau of Coal Statistics. Statistics of receipts and shipments from tidewater were compiled from records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce, from reports furnished by the railroads over which the coal was delivered to tidewater, from reports of United States Army engineers, and from figures and estimates furnished to the author by persons familiar with this movement.

The total quantity of coal shipped from the mines in each producing State to points within that State and in other States by rail or by river was obtained by subtracting from the total shipments of each State, as reported by the operators and as shown in Part A of this report, the coal supplied to railroads, shipped to the Great Lakes for cargo, shipped to tidewater,[1] and exported to Canada and Mexico by rail. The information compiled from reports furnished by operators, distributors, and others, to show the destination of coal by States, was used to show the distribution of this interior rail movement. Incomplete figures were supplemented by estimates obtained by the author from reliable sources by personal visits to trade centers in the East and the Middle West. The statistics compiled by the Illinois-Indiana Coal Traffic Bureau, the Ohio Bureau of Coal Statistics, and the St. Louis Coal Traffic Bureau were of special value in completing the figures for Illinois, Indiana, Ohio, and Missouri.

The possibility of duplication in the figures submitted, through the same coal having been handled by more than one individual or company making reports to the Geological Survey, was recognized. In preparing the data for tabulation care was taken to eliminate all apparent duplication, and in doubtful instances to obtain supple-

[1] Coal shipped to tidewater at New York Harbor but used in the city of New York is not included in the tidewater figures in this report. See p. 501.

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mental statements from the companies. Many of the Survey's correspondents voluntarily gave information as to the possibiliy of duplication and in many ways rendered valuable assistance that was not specifically requested.

The final results of such an investigation as this can not, of course, be more accurate than the items from which they are compiled. Not all the companies were able to furnish exact figures in the form requested. A few of them—10 to 15 per cent of those reporting—supplied estimates based on their records of cars shipped and the value of product sold in different markets, or, for some items, merely upon their general knowledge of the year's business.

The quantities of coal used by railroads and consumed in the manufacture of coke and coal gas were obtained from the reports of the users and are, of course, as accurate as they can be made. Likewise the statistics of exports, imports, and foreign bunker fuel are official figures, and there can be no question as to the completeness and accuracy of the data on lake cargo shipments, prepared by the Ohio Bureau of Coal Statistics.

Operators or their agents not uncommonly ship coal to such centers of traffic as Buffalo or Chicago on consignment and to the order of a broker or another company. So far as the records of the original shipper are concerned, Buffalo or Chicago is the destination of that coal, whereas it was probably reconsigned and shipped to market at some other point, near or distant. Some of those who reported shipments of this character were able also to supply estimates showing the final destination of the coal; others gave the names of the consignees, from some of whom further data were collected by the Survey. A condition so complex made the accuracy of some of the reports received doubtful, and the doubt could be removed only by a volume of correspondence that would probably have overtaxed the patience of the officials of the companies that supplied the information.

On the assumption, therefore, that all coal produced was distributed, it appears that any inaccuracy in the statistics given in this report will lie mainly in the records of shipments to States. Although the plan adopted may appear to assume greater accuracy than can be claimed, the total coal distributed from each State has been balanced with the total production, the quantities being shown to the nearest ton, though they are not accurate to that degree.

UNIT OF MEASUREMENT.

The net ton of 2,000 pounds has been used uniformly throughout this report, for a common unit was necessary throughout the tables in order that quantities might be compared with ease. Except in Maryland, West Virginia, and parts of Pennsylvania most of the coal operators use the net ton. The statistics for Pennsylvania anthracite and of bituminous coal shipped for export and of coastwise and bunker fuel at tidewater were reported in gross tons but were converted to net tons for use in the report. Although the gross ton is commonly used by railroads and other transportation companies in the territory near the Atlantic coast, the net ton is used in the retail trade throughout a large part of that region for both bituminous coal and anthracite.

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ACKNOWLEDGMENTS.

The author wishes to acknowledge with thanks and appreciation the hearty cooperation of the many operators, selling agents, brokers, and others whose detailed reports, many of them prepared at considerable expense, furnish the foundation for these statistics. Thanks are also extended to the officials of railroads, to the district officers of the Corps of Engineers of the United States Army, to commercial organizations, and to the many individuals whose willing assistance has been of value in the work of compiling these figures. Wherever possible throughout the report special mention and credit have been given for data furnished. Grateful acknowledgment is also made to Miss Lida Mann, Miss R. M. McKinney, and others of the Geological Survey for valuable clerical assistance in preparing the figures for publication, and to Mr. J. A. Dorsey, also of the Survey staff, who compiled the statistics of exports and bunker coal from the records of the Bureau of Foreign and Domestic Commerce.

DISTRIBUTION OF BITUMINOUS COAL AND LIGNITE.

GENERAL FEATURES.

The statistics collected from the operators of coal mines and published in Part A of this report show the quantities of bituminous coal and lignite (1) used at the mines for generating steam and heat, (2) sold locally or used by employees, (3) used at the mines for making coke (none of this coal is shipped), and (4) shipped to market, either by rail or by river. The destination and use of the coal embraced in the first three items are thus recorded, but a special investigation was necessary to determine the destination and use of the coal shipped, which forms 86 per cent of the quantity produced.

Coal reaches the market by three general methods of transportation—(1) all-rail, with which in this report are included the shipments by rivers; (2) rail to tidewater, thence to vessel to foreign markets (exports) or by vessel to other points on the coasts of the United States or its insular possessions (coastwise), or used at tidewater points for fuel on steamships (bunker); (3) rail to the Great Lakes, notably to lower Lake ports on Lake Erie, thence by boat to upper Lake ports on Lake Superior or Lake Michigan or to Canada, and from upper Lake ports again by rail to markets in the interior.

One of the purposes of this investigation was to ascertain the quantity of coal consumed in each State for domestic and industrial uses as distinguished from that consumed by railroads and in the manufacture of coke and coal gas. Statistics collected from the manufacturers of coke and coal gas[1] showed the quantity of coal consumed in those industries, and statistics obtained directly from the railroad companies (see pp. 473–474) showed the quantity consumed by the railroads. It was not considered practicable to attempt to ascertain the quantities of coal consumed by railroads within individual States, so the quantity thus used, which is distributed by all

[1] See reports on coke and on artificial gas and by-products in 1915 in other chapters of Mineral Resources.

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three methods of delivery, is shown separately in the accompanying table and throughout the report.

The all-rail movement, which, as has been explained, includes shipments by rivers, is separated into (1) shipments to points within the State in which the coal was mined, with which, for convenience, are included quantities not shipped, used at the mines for steam and heat, and used locally and by employees at the coal mines; (2) shipments to other States; (3) quantities used by railroads serving the coal fields or delivered by them to other railroads; and (4) exports to Canada and Mexico by rail. The details of the shipments to other States and of the tidewater and lake movements are given in succeeding tables.

DISTRIBUTION BY ALL-RAIL ROUTES.

About 96 per cent of the coal produced in the United States is used in this country, and 86 per cent of the total output in 1915 reached the point of consumption by rail. The States in which the coal is mined are the largest users of fuel, and 33 per cent of the output of bituminous coal in 1915 was consumed in the States where it was produced. Of the total output 27 per cent was shipped to other States by rail and 26 per cent was taken by railroads entering the coal fields or having all-rail connection with the producing districts.

Among the large coal-producing States West Virginia is exceptional as regards coal used within its borders, for in 1915 only 8 per cent of the coal mined in that State was used there, compared with 38 per cent for Pennsylvania, 45 per cent for Illinois, and 43 per cent for Ohio.

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Distribution of bituminous coal produced in the United States, 1915, by routes and destination.

Source.	All-rail shipments.								Shipped to tide-water.		Shipped to Great Lakes for cargo.		Total quantity (net tons).
	Used within the State.		Shipped to other States.		Used by railroads.		Exported by rail.						
	Quantity (net tons).	Percentage of production.	Quantity (net tons).	Percentage of production.	Quantity (net tons).	Percentage of production.	Quantity (net tons).	Percentage of production.	Quantity (net tons).	Percentage of production.	Quantity (net tons).	Percentage of production.	
Alabama	7,347,886	49	2,003,717	14	5,072,435	34	.....	.....	503,899	3	.....	.....	14,927,937
Alaska	1,400	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,400
Arkansas	238,386	14	610,425	37	803,295	49	.....	.....	.....	.....	.....	.....	1,652,106
California, Idaho, and Nevada	12,503	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12,503
Colorado	4,987,475	58	1,248,990	14	2,388,515	28	(a)	.....	.....	.....	.....	.....	8,624,980
Georgia	120,772	90	8,724	6	5,000	4	.....	.....	.....	.....	.....	.....	134,496
Illinois	26,781,713	45	13,119,841	22	18,928,022	33	.....	.....	.....	.....	.....	.....	58,829,576
Indiana	6,394,019	38	4,423,583	26	6,188,550	36	.....	.....	.....	.....	.....	.....	17,006,152
Iowa	2,786,570	37	411,741	5	4,415,832	58	.....	.....	.....	.....	.....	.....	7,614,143
Kansas	1,879,725	28	1,790,248	26	3,154,501	46	.....	.....	.....	.....	.....	.....	6,824,474
Kentucky	4,429,055	21	11,580,796	54	4,649,823	22	.....	.....	.....	.....	702,000	3	21,361,674
Maryland	852,169	20	1,892,027	45	387,121	10	(a)	.....	1,049,160	25	.....	.....	4,180,477
Michigan	761,217	66	.....	.....	394,921	34	(a)	.....	.....	.....	.....	.....	1,156,138
Missouri	1,059,416	28	400,237	10	2,351,940	62	.....	.....	.....	.....	.....	.....	3,811,593
Montana	1,638,750	59	100,686	3	1,050,319	38	.....	.....	.....	.....	.....	.....	2,789,755
New Mexico	1,066,438	28	777,437	20	1,635,752	43	155,030	4	193,283	5	.....	.....	3,817,940
North Dakota	519,969	98	5,000	1	3,109	1	.....	.....	.....	.....	.....	.....	528,078
Ohio	9,663,496	43	2,317,036	10	7,895,733	35	60,811	.9	15,000	.01	[b]2,482,615	11	22,434,691
Oklahoma	722,555	20	397,275	11	2,573,750	69	.....	.....	.....	.....	.....	.....	3,693,580
Oregon	32,315	82	.....	.....	5,000	13	.....	.....	1,916	5	.....	.....	39,231
Pennsylvania	59,993,642	38	40,220,496	26	30,294,892	19	3,866,406	2	13,960,000	9	[c]9,619,701	6	157,955,137
South Dakota	10,593	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,593
Tennessee	1,340,737	23	1,014,163	18	3,375,461	59	.....	.....	.....	.....	.....	.....	5,730,361
Texas	873,456	42	.....	.....	1,037,249	50	78,203	3	100,000	5	.....	.....	2,088,908
Utah	1,903,749	61	639,477	21	565,489	18	.....	.....	.....	.....	.....	.....	3,108,715
Virginia	2,004,344	25	2,824,961	35	2,526,716	31	.....	.....	[d]766,575	9	.....	.....	8,122,596
Washington	932,488	39	197,090	8	1,149,446	47	.....	.....	150,071	6	.....	.....	2,429,095
West Virginia	6,000,117	8	32,555,406	42	9,478,401	12	42,913	.....	[e]20,405,060	27	[f]8,702,172	11	77,184,069
Wyoming	609,546	9	1,721,011	26	4,223,290	65	181	.....	.....	.....	.....	.....	6,554,028
	[g]144,954,501	33	[h]120,260,367	27	[i]114,554,562	26	[j]4,203,544	1	37,144,964	8	21,506,488	5	442,624,426

a Included in shipments to other States.
b Includes 310,395 tons used by railroads in the Great Lakes region.
c Includes 3,435,693 tons used by railroads in the Great Lakes region.
d Includes 300,000 tons used by railroads in New England.
e Includes 1,776,419 tons used by railroads in New England.
f Includes 800,134 tons used by railroads in the Great Lakes region.
g Includes coal used at mines for steam and heat, and that sold to local trades and used by employees, and made into coke at the mines, none of which is shipped.
h Includes 100,397 tons from Colorado, Kentucky, and Maryland, exported by rail.
i All-rail delivery only (see table on pages 474–475 for complete figures).
j Does not include 100,397 tons from Colorado, Kentucky, and Maryland exported by rail and included under shipments to other States. Total exports by rail were 4,303,941 net tons.

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DISTRIBUTION OF TIDEWATER SHIPMENTS.

The tidewater shipments of bituminous coal in the United States in 1915 were about 37,100,000 net tons. This quantity includes coal dumped at tidewater points on the Atlantic, Pacific, and Gulf coasts (including that floated down Mississippi River) and shipped to foreign countries, shipped coastwise for points in the United States, and used for bunker fuel for steamers in both foreign and domestic trade. It does not include the coal dumped at New York and used in the city (see p. 501), but it does include coal dumped at Baltimore and Philadelphia and used either on Chesapeake Bay "inside the capes," or on Delaware Bay, or on Delaware River.

The statistics showing the quantity of bituminous coal shipped to tidewater and its origin were collected without great difficulty, but the collection of statistics showing the disposition of this coal has presented one of the most complicated problems connected with the preparation of this report. The figures of the Bureau of Foreign and Domestic Commerce have been accepted for foreign exports and foreign bunker, and an acceptable figure has been obtained for the quantity of bituminous coal used for bunker fuel in the domestic trade (see p. 475). The remainder was coastwise movement for consumption on land. A part of the coastwise cargo coal is ultimately used for bunkering vessels, and the quantity so used appears in the statements of bunker coal as well as in the statistics of coastwise movement.

The origin of the coal shipped to tidewater is shown in the table on page 439. Ten States contributed to the total, of which more than 34,300,000 tons, or 92 per cent, was from Pennsylvania and West Virginia. The tidewater shipments in 1915 from West Virginia were 20,400,000 net tons, or 27 per cent of the production in that State. These shipments reached the seaboard at all the important coal ports on the Atlantic—Hampton Roads, Baltimore, Philadelphia, and New York. The tidewater shipments from Pennsylvania were 13,960,000 net tons, or 9 per cent of the production of bituminous coal in that State in 1915. These shipments were dumped into vessels at Baltimore, Philadelphia, and New York. Coal from Maryland reaches tidewater at Washington, D. C., by way of the Chesapeake & Ohio Canal, at Baltimore, at Philadelphia, and to a small extent at New York.

Tidewater deliveries at points on the Gulf of Mexico are received from Alabama, Texas, and New Mexico. Coal from Alabama also reaches tidewater at ports in South Carolina and Georgia, as does some coal from Virginia. The greater part of the tidewater shipments from Virginia, however, are dumped at Hampton Roads. The unusual condition in coal transportation in 1915, caused by shortages of coal cars in the Eastern States, permitted a small quantity of coal from Ohio (15,000 net tons) to reach the Atlantic seaboard, although under normal conditions no coal from that State is moved to tidewater.

The coal that reaches tidewater on the Pacific coast is shipped from mines in Washington and Oregon. In 1915 150,071 net tons were shipped to Puget Sound from Washington coal fields and 1,916 net tons to Coos Bay, Oreg., from the near-by coal field. Some coal from

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Wyoming, Utah, or New Mexico is doubtless used at San Francisco and Los Angeles for bunker fuel, but no statistics to show that fact are available.

The coal shipped to tidewater is used for bunkering steamships, is exported to foreign countries, or is shipped coastwise and used on land at points in the United States other than those at which it was loaded on vessels, or is loaded on other vessels for bunker fuel. In other words, the statistics of the total coastwise shipments and the total bunker coal, as reported, involve some duplication. The following table shows as nearly as can be ascertained the distribution of the tidewater shipments in 1915. The exports to foreign countries ("offshore" movement) were 9,178,484 net tons, the coastwise shipments for consumption on land were 16,551,480 tons (15,350,000 tons for New England and 1,201,480 tons for other points, mainly on Chesapeake Bay), and the bunker fuel supplied was 11,415,000 tons, a total of 37,144,964 net tons, or 8 per cent of the production in 1915.

Shipments of coal to tidewater in 1915.

	Net tons.
Foreign export	9,178,484
Coastwise shipments:	
For consumption in New England	[1] 15,350,000
For consumption at other United States ports	1,201,480
Total coastwise shipments for consumption on land	16,551,480
For bunker fuel	2,148,520
Total coastwise shipments	18,700,000
Bunker coal (foreign and domestic trade):	
Loaded at New York, Philadelphia, Baltimore, Hampton Roads, and New Orleans	8,882,000
Loaded at Porto Rico, Hawaii, Alaska, and San Francisco	255,000
Loaded at all other ports	2,278,000
Total bunker coal	11,415,000
Total tidewater shipments	[2] 37,144,964

DISTRIBUTION OF LAKE CARGO SHIPMENTS.

The statistics presented in the following table, covering the distribution of bituminous coal from the docks at the head of the Lakes in 1915, are based on detailed reports from the six largest companies with docks on Lake Michigan and Lake Superior, reports from all the important railroads that reach the upper Lakes, reports of Army engineers, and the report of the Milwaukee Chamber of Commerce, supplemented by estimates received from reliable sources. No figures by which these statistics may be checked are available, and it is, therefore, not possible to test their accuracy, but it is believed that they represent very closely the business done in the Great Lakes region.

According to these statistics nearly 22,000,000 tons of bituminous coal were received at the upper Lake ports of the United States and

[1] Includes 2,076,419 tons used by railroads.
[2] In this total the bunker coal included in coastwise shipments (2,148,520 tons) is counted only once, though it is also included in the total bunker coal (11,415,000 tons).

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Canada in 1915. The coal received at Canadian ports and shipped by rail to Canada from American ports amounted to about 5,300,000 net tons, or 24 per cent of the total Lake coal. The railroads used 4,500,000 tons, or 21 per cent of the total, and 12,100,000 tons was shipped to interior points or used at the city or port where it was received. Wisconsin used about 4,900,000 tons, Minnesota about 3,800,000 tons. The receipts at Chicago and adjacent points in Indiana at the lower end of Lake Michigan were more than 1,500,000 tons.

The quantity distributed appears to have been about 500,000 tons greater than the receipts.

Distribution of Lake cargo bituminous coal, 1915.

	Quantity (net tons).	Percentage of total.
Shipped to States by rail from docks on Lake Superior and Lake Michigan:		
Idaho	1,000	
Illinois	1,084,000	
Indiana	551,000	
Iowa	248,000	
Michigan	558,000	
Minnesota	3,793,000	
Montana	3,000	
Nebraska	100,000	
North Dakota	553,000	
Oregon	500	
South Dakota	357,000	
Washington	100	
Wisconsin	4,883,000	
	12,131,600	55
Used by railroads in the Northwest	4,546,222	21
Exported to Canada by water and rail	5,291,357	24
Total distributed from upper Lake ports	21,969,179	100
Shipments of lake cargo from lower Lake ports	21,506,488	
Shipments from upper Lake docks in excess of receipts	462,691	

BITUMINOUS COAL AND LIGNITE SHIPPED BY RAILROADS AND RIVERS.

According to the reports furnished to the Geological Survey by the coal operators, bituminous coal and lignite shipped by railroads in 1915 amounted to 370,336,585 net tons, compared with 355,855,510 tons in 1914. The shipments, which are summarized by railroads in the accompanying table, include all coal loaded on cars at the mines. A small part of the coal shipped is carried but a short distance, perhaps only switched from the tipple to coke ovens or to some near-by industrial plant, but the greater part is moved a considerable distance from the mines. As these statistics include fuel coal taken by railroads that serve the coal mines, not all the shipments furnished revenue to the railroads, coal for "company use" being nonrevenue freight. The statistics of coal traffic published by a railroad company usually show only revenue freight and include coal received from connecting lines as well as that originating at mines on the line. For that reason the figures given in the following table will be at variance with those that may be compiled by the railroads.

The table of railroad shipments in this report is arranged in a form different from that of the tables in previous reports of the

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series. The quantities of bituminous coal and lignite shipped on each road are given in so far as they can be published without disclosing the output of individual mines, rather than combined, as in previous reports, according to the railroad system to which the roads belong, and the names of the roads are arranged in alphabetic order rather than in the order of the importance of the roads as coal carriers. The name of every railroad on which coal was reported to have originated is given, with (for most of the roads) the quantity from each State. Roads on which the mines are operated by less than three companies are grouped at the end of the table in such manner as not to disclose the operation of mines or companies.

Shipments originating on rivers are given at the end of the table.

Shipments of bituminous coal in the United States, by railroads and waterways, in 1915.

Route.	State.	Quantity.	Total.
Railroad.		*Net tons.*	*Net tons.*
Alabama Great Southern	Alabama	51,507	51,507
Arkansas Central	Arkansas	11,101	11,101
Ashland Coal & Iron	Kentucky	91,579	91,579
Atchison, Topeka & Santa Fe (includes New Mexico Midland and Santa Fe, Raton & Eastern)	Colorado	491,322	5,157,375
	Illinois	410,510	
	Kansas	1,589,075	
	Missouri	253,386	
	New Mexico	2,278,378	
	Oklahoma	134,704	
Atlanta, Birmingham & Atlantic	Alabama	180,859	180,859
Baltimore & Ohio (includes Sandy Valley & Elkhorn)	Illinois	1,161,119	32,723,535
	Kentucky and Maryland.	1,376,571	
	Ohio	4,438,401	
	Pennsylvania	10,921,949	
	West Virginia	14,825,495	
Baltimore & Ohio Southwestern	Illinois and Indiana.	504,387	863,717
	Ohio	359,330	
Bessemer & Lake Erie	Pennsylvania	2,638,922	2,638,922
Birmingham Southern	Alabama	2,390,482	2,390,482
Buffalo, Rochester & Pittsburgh	Pennsylvania	6,728,400	6,728,400
Centerville, Albia & Southern	Iowa	7,855	7,855
Central of Georgia	Alabama and Georgia.	788,716	788,716
Chesapeake & Ohio (includes Piney River & Paint Creek)	Kentucky	2,026,570	22,993,769
	West Virginia	20,967,199	
Chicago & Alton	Illinois	2,232,409	2,427,055
	Missouri	194,646	
Chicago & Eastern Illinois	Illinois	4,197,277	8,552,123
	Indiana	4,354,846	
Chicago & Northwestern (includes Wyoming & Northwestern)	Illinois	3,497,417	5,156,843
	Iowa	1,510,090	
	Wyoming	149,336	
Chicago, Burlington & Quincy	Colorado and Wyoming.	1,933,108	11,828,656
	Illinois	8,460,895	
	Iowa	1,100,075	
	Missouri	334,578	
Chicago Great Western	Iowa	497,111	497,111
Chicago, Indianapolis & Louisville	Indiana	971,302	971,302
Chicago, Milwaukee & St. Paul	Illinois	1,438,230	3,688,018
	Iowa	1,382,737	
	Montana, South Dakota, and Washington.	858,852	
	North Dakota	8,199	
Chicago, Peoria & St. Louis	Illinois	570,277	570,277
Chicago, Rock Island & Pacific (includes Chicago, Rock Island & Gulf)	Arkansas	189,738	3,366,347
	Colorado, Missouri, and Texas.	165,864	
	Illinois	159,319	
	Iowa	1,778,033	
	Oklahoma	1,073,393	
Chicago, Terre Haute & Southeastern	Indiana	3,363,549	3,363,549
Cincinnati, Hamilton & Dayton	Illinois	187,659	418,116
	Ohio	230,457	
Cincinnati, New Orleans & Texas Pacific	Kentucky	86,526	383,209
	Tennessee	296,683	

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Shipments of bituminous coal in the United States, by railroads and waterways, in 1915—Continued.

Route.	State.	Quantity.	Total.
Railroad—Continued.		*Net tons.*	*Net tons.*
Cleveland, Cincinnati, Chicago & St. Louis	Illinois	6,962,652	8,052,936
	Indiana	1,090,284	
Coal & Coke	West Virginia	858,461	858,461
Colorado & Southern	Colorado	1,884,512	1,884,512
Colorado Midland	do	237,431	237,431
Cumberland	Kentucky	310,972	310,972
Cumberland & Georges Creek	Maryland	337,629	337,629
Cumberland & Pennsylvania	do	2,908,404	2,908,404
Denver & Rio Grande (includes Ballard & Thompson, Kenilworth & Helper, and Rio Grande Southern)	Colorado and New Mexico.	1,967,983	4,239,784
	Utah	2,271,801	
Denver & Salt Lake	Colorado	823,560	823,560
Detroit, Toledo & Ironton	Ohio	233,552	233,552
Elgin, Joliet & Eastern	Illinois	304,510	304,510
Erie	Ohio	106,695	1,900,142
	Pennsylvania	1,793,447	
Evansville, Suburban & Newburgh	Indiana	99,425	99,425
Fort Dodge, Des Moines & Southern	Iowa	63,052	63,052
Frisco (includes Alabama Central, Birmingham Belt, and B. R. L. & P. (Huntingdon)	Alabama	1,793,672	5,397,975
	Arkansas	467,913	
	Kansas	2,364,463	
	Missouri	266,764	
	Oklahoma	505,163	
Great Northern	Montana	648,831	700,820
	North Dakota and Washington.	51,989	
Harriman & Northeastern	Tennessee	278,428	278,428
Hocking Valley	Ohio	2,764,937	2,764,937
Huntingdon & Broad Top Mountain	Pennsylvania	792,218	792,218
Illinois Central	Alabama	95,553	13,925,913
	Illinois	10,006,171	
	Indiana	242,704	
	Kentucky	3,581,485	
Illinois Southern	Illinois	220,632	220,632
Illinois Traction System	do	350,772	350,772
Indian Creek Valley	Pennsylvania	13,644	13,644
International & Great Northern	Texas	316,855	316,855
Iowa & St. Louis	Iowa and Missouri.	67,015	67,015
Kanawha & Michigan	Ohio	550,627	3,450,241
	West Virginia	2,899,614	
Kansas City Southern (includes Arkansas Western)	Arkansas & Oklahoma.	139,168	844,063
	Kansas	574,184	
	Missouri	130,711	
Kentucky & Tennessee	Kentucky	480,241	480,241
Lake Erie, Franklin & Clarion	Pennsylvania	388,858	388,858
Ligonier Valley	do	829,067	829,067
Litchfield & Madison	Illinois	883,911	883,911
Louisville & Nashville (includes Warrior Mineral)	Alabama	3,229,139	13,569,642
	Illinois and Indiana.	389,900	
	Kentucky	8,376,753	
	Tennessee	1,362,554	
	Virginia	211,296	
Louisville, Henderson & St. Louis	Kentucky	86,001	86,001
Marietta, Columbus & Cleveland	Ohio	117,616	117,616
Michigan Central	Michigan	514,262	514,262
Midland Valley	Arkansas	234,848	294,106
	Oklahoma	59,258	
Minneapolis & St. Louis	Illinois	629,237	1,045,681
	Iowa	416,444	
Minneapolis, St. Paul & Sault Ste. Marie	Montana and North Dakota.	162,683	162,683
Missouri, Kansas & Texas (includes Wichita Falls & Southern)	Kansas	851,868	2,382,263
	Missouri	77,888	
	Oklahoma	1,059,996	
	Texas	392,511	
Missouri, Oklahoma & Gulf	Oklahoma	402,515	402,515
Missouri Pacific	Arkansas	52,309	2,219,987
	Kansas	1,110,005	
	Missouri	1,057,073	
Mobile & Ohio	Alabama	309,162	1,058,192
	Illinois	749,030	
Monongahela	Pennsylvania	458,425	547,856
	West Virginia	89,431	
Montana, Wyoming & Southern	Montana	421,891	421,891
Montour	Pennsylvania	2,684,010	2,684,010
Nashville, Chattanooga & St. Louis	Alabama and Tennessee.	1,068,870	1,068,870
New York Central (includes Lake Shore & Michigan Southern and New York Central & Hudson River)	Ohio	1,396,557	9,734,495
	Pennsylvania	8,337,938	

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Shipments of bituminous coal in the United States, by railroads and waterways, in 1915—Continued.

Route.	State.	Quantity.	Total.
Railroad—Continued.		*Net tons.*	*Net tons.*
Norfolk & Western	Kentucky	2,115,304	26,839,534
	Virginia	2,633,874	
	West Virginia	22,090,356	
Northern Pacific	Montana	646,335	2,219,186
	North Dakota	140,014	
	Washington	1,432,837	
Pennsylvania (includes Pittsburgh, Cincinnati, Chicago & St. Louis).	Maryland	30,661	64,093,980
	Ohio	6,024,037	
	Pennsylvania	57,059,578	
	West Virginia	979,704	
Peoria & Pekin Union	Illinois	323,498	323,498
Peoria Railway Terminal Co	do	323,080	323,080
Pere Marquette (includes Detroit, Bay City & Western)	Michigan	563,683	563,683
Pittsburgh & Lake Erie	Pennsylvania	7,112,110	7,112,110
Pittsburgh & Susquehanna	do	190,179	190,179
Pittsburgh, Chartiers & Youghiogheny	do	793,273	793,273
Pittsburgh, Lisbon & Western	Ohio and Pennsylvania.	68,373	68,373
Pittsburgh, Shawmut & Northern	Pennsylvania	2,666,986	2,666,986
Quincy, Omaha & Kansas City	Missouri	143,592	143,592
St. Louis, Iron Mountain & Southern (includes Dardanelle & Russellville).	Arkansas	580,962	3,425,647
	Illinois	2,844,685	
St. Louis Southwestern Railway of Texas	Texas	59,884	59,884
Southern (includes Northern Alabama)	Alabama	2,895,131	6,943,086
	Illinois and Indiana.	1,605,972	
	Kentucky	581,482	
	Tennessee	1,860,501	
Southern Pacific (includes Coos Bay, Roseburg & Eastern, Galveston, Harrisburg & San Antonio, and Houston & Texas Central).	California and Oregon.	29,711	140,070
	Texas	110,359	
Tennessee Central	Tennessee	337,471	337,471
Toledo & Ohio Central	Ohio	945,820	945,820
Toledo, Peoria & Western	Illinois	154,305	154,305
Toledo, St. Louis & Western	Illinois and Indiana.	619,723	619,723
Union Pacific System (includes Colorado, Wyoming & Eastern, Oregon Short Line, and Oregon-Washington R. R. & Navigation Co.).	Colorado	387,381	5,116,978
	Kansas	45,677	
	Missouri and Utah	75,311	
	Washington	110,264	
	Wyoming	4,498,345	
Vandalia	Illinois	820,239	5,518,162
	Indiana	4,697,923	
Virginia & Kentucky	Virginia	38,457	38,457
Virginia & Southwestern	Kentucky and Virginia.	1,956,045	1,956,045
Virginian	Virginia and West Virginia.	4,002,365	4,002,365
Wabash	Illinois	2,376,508	2,667,683
	Iowa and Missouri.	291,175	
Wabash, Chester & Western	Illinois	36,909	36,909
Wabash Pittsburgh Terminal	Ohio and West Virginia.	116,664	699,137
	Pennsylvania	582,473	
Western Allegheny	do	376,628	376,628
Western Maryland	Maryland	690,872	3,690,249
	Pennsylvania	88,052	
	West Virginia	2,911,325	
West Virginia Northern	do	169,850	169,850
Wheeling & Lake Erie	Ohio	1,751,918	1,751,918
Zanesville & Western	do	595,264	595,264
Miscellaneous:			
Seaboard Air Line	Alabama	380,255	380,255
Thomas & Sayreton			
Colorado & Southeastern	Colorado	858,413	858,413
Colorado & Wyoming			
Denver & Intermountain			
Trinidad Electric			
Chicago & Illinois Midland	Illinois	1,301,436	1,301,436
Chicago, Indiana & Southern			
East St. Louis & Suburban	do	1,930,312	1,930,312
St. Louis & Belleville Electric			
St. Louis & O'Fallon			
St. Louis, Troy & Eastern			
Lake Erie & Western	do	270,320	270,320
Rock Island Southern			
Unspecified	do	4,320	4,320
Central Indiana	Indiana	65,327	65,327
Evansville Belt			
Unspecified			

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Shipments of bituminous coal in the United States, by railroads and waterways, in 1915—Continued.

Route.	State.	Quantity.	Total.
Railroad—Continued.			
Miscellaneous—Continued.			
Colfax Northern Interurban Eastern Kentucky Kentucky Midland K. R. & C Morehead & North Fork Ohio & Kentucky Bevier & Southern Kansas City, Clinton & Springfield St. Louis & Hannibal El Paso & Southwestern New Mexico Central Lake Erie, Alliance & Wheeling Ohio River & Western Youngstown & Ohio River Youngstown & Southern Electric Fort Smith & Western Fort Smith, Poteau & Western Altoona Northern Cambria & Indiana Johnstown & Stony Creek Kittanning Run Buffalo & Susquehanna R. R. Corp Indiana County Street Railways Reynoldsville & Falls Creek Rural Valley Central Pennsylvania Lumber Co. Tramroad Susquehanna & New York East Broad Top R. R. & Coal Co Juniata & Southern Eastern Ohio Tramway Union West Side Belt New Haven & Dunbar United Railway Washington Run Rio Grande & Eagle Pass San Antonio & Aransas Pass Texas & Pacific Texas Short Line Trinity & Brazos Valley Carolina, Clinchfield & Ohio Interstate Unspecified Centralia Eastern Columbia & Puget Sound Puget Sound & Willapa Harbor Puget Sound Electric Tacoma Eastern Buffalo Creek & Gauley Morgantown & Kingwood Preston West Virginia Midland Campbells Creek Kanawha & West Virginia Kanawha Central Cherry River Boom & Lumber Co Kanawha, Glen Jean & Eastern	Iowa Kentucky Missouri New Mexico Ohio Oklahoma Pennsylvania ...do ...do ...do ...do Texas Virginia Washington West Virginia ...do ...do	136,595 138,030 445,793 737,644 364,330 39,136 1,222,747 2,429,944 17,131 602,058 2,299,132 394,439 1,093,813 2,191,087 530,811 1,100,354 665,390 414,260	136,595 138,030 445,793 737,644 364,330 39,136 1,222,747 2,429,944 17,131 602,058 2,299,132 394,439 1,093,813 2,191,087 530,811 1,100,354 665,390 414,260
Total railroad shipments		370,336,585	370,336,585
Waterway.			
Kanawha River	West Virginia	877,668	877,668
Monongahela River	Pennsylvania and West Virginia	7,726,998	7,726,998
Ohio River	Indiana and West Virginia Kentucky Ohio	41,597 595,629 103,862	741,088
Warrior River	Alabama	169,618	169,618
Miscellaneous: Coquille River Green River Illinois River	Oregon Kentucky Illinois	24,634	24,634
Total waterway shipments		9,540,006	9,540,006
Grand total		379,876,591	379,876,591

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DISTRIBUTION BY STATES.

ALABAMA.

In its output of coal Alabama is the most productive State in the South, and it is centrally located as regards the markets of the Southern States. In 1915 the southern railroads used nearly 5,000,000 tons of Alabama coal, which is 32 per cent of the production in Alabama and nearly 23 per cent of the consumption by the railroads in the South. About 200,000 tons of coal from Alabama was used by railroads west of Mississippi River. In addition to that taken by the railroads, more than 7,300,000 tons, or nearly half the total output, was used in the State; 2,000,000 tons, or 13.5 per cent of the output, was shipped to other States; and 500,000 tons, or 3.5 per cent, went to tidewater for foreign and domestic cargo and bunker fuel. Of the coal shipped outside the State for commercial use the greater part, about 1,500,000 tons, reached the Mississippi Valley markets in Louisiana and Mississippi and in a less amount those in Missouri, Tennessee, and Arkansas. On the east, Georgia and Florida are the best consumers of Alabama coal.

Competition by coal from the fields to the north, particularly those of southern Illinois and western Kentucky, restricts the expansion of markets for coal from Alabama in the Mississippi Valley and at New Orleans. Similar competition on the east by coal from Virginia, Kentucky, and Tennessee meets coal from Alabama in the markets of the Carolinas and Georgia. The higher grades of Alabama coal are sent in small shipments to markets as distant as the Pacific coast. The tidewater business at southern Atlantic ports (except Hampton Roads) and at gulf ports is not very large as compared with that at the northern ports, and in 1915 it was below normal. About 500,000 tons of coal from Alabama reached tidewater in 1915.

Coal shipped to tidewater points from Alabama in 1915, in net tons.

Port.	Quantity.	Use.	Quantity.
Mobile, Ala.	103,320	Foreign export	23,641
Pensacola, Fla.	145,369	Foreign bunker	319,307
New Orleans, La.	116,205	Domestic bunker	160,951
South Carolina ports	11,904		
Georgia ports	127,101		
	503,899		503,899

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Distribution of coal mined in Alabama in 1915.

	Quantity (net tons)	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Alabama.....			Shipped to other States—Continued.		
Used at mines for steam and heat.....	535,340		Oklahoma.....	713	
Sold to local trade, not shipped.....	230,220		Oregon.....	190	
Made into coke at mines.	1,780,872		Tennessee.....	161,754	
Shipped to Alabama points.....	4,742,435		Texas.....	39,987	
			Virginia.....	307	
			Washington.....	21	
Total used in Alabama	7,347,886	49	Total shipped to other States (all rail).....	2,003,717	14
Shipped to other States:					
Arkansas.....	10,450		Shipped to tidewater.....	503,899	3
California.....	292		Used by railroads:		
Florida.....	108,782		Loaded at mine tipples.	100,000	
Georgia.....	363,572		Shipped.....	4,972,435	
Louisiana.....	717,437				
Mississippi.....	596,218		Total used by railroads.....	5,072,435	34
Missouri.....	3,519				
North Carolina and South Carolina.....	475		Total production.....	14,927,937	100

ARKANSAS.

Of the total coal mined in Arkansas in 1915 nearly half (800,000 net tons) was used as fuel by railroads. Of the remainder about 240,000 tons was consumed in Arkansas and approximately 610,000 tons was distributed in near-by States for commercial and domestic uses. The greater part of the coal (other than railroad fuel) that is shipped from Arkansas reaches markets to the north and west, in Missouri, Kansas, and Nebraska. The better grades of Arkansas coal, which are semianthracite, find a small market in the neighboring States of Oklahoma, Texas, and Louisiana, west of the Mississippi, and in Tennessee, east of the Mississippi, and some Arkansas coal is shipped to Iowa and Minnesota.

Distribution of coal produced in Arkansas in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Arkansas:			Shipped to other States—Continued.		
Used at mines for steam and heat.....	62,175		Minnesota.....	5,372	
Sold to local trade, not shipped.....	46,260		Missouri.....	198,768	
Shipped to points in Arkansas.....	129,951		Nebraska.....	120,376	
			Oklahoma.....	60,791	
			Tennessee.....	15,258	
			Texas.....	78,418	
Total used in Arkansas.....	238,386	14	Total shipped to other States (all rail).....	610,425	37
Shipped to other States:					
Iowa.....	16,537		Used by railroads.....	803,295	49
Kansas.....	114,812				
Louisiana.....	93		Total production.....	1,652,106	100

COLORADO.

In view of the relative excellence of the coal mined in Colorado and the advantageous location of the more productive developed fields on the east front of the Rocky Mountains, it is surprising that so little Colorado coal finds markets in the region east of the State. In 1915 only 1,250,000 tons, or 14 per cent of the output, was shipped

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to other States, Kansas, Nebraska, Oklahoma, and Texas taking the greater part of this quantity. The coal consumed within the State in 1915, including that used for operating the coal mines and for making coke, amounted to nearly 5,000,000 tons, or 58 per cent of the production, and railroads used nearly 2,400,000 tons, or 28 per cent.

Distribution of coal produced in Colorado in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Colorado:			Shipped to other States—Continued.		
Used at mines for steam and heat	294,571		Nebraska	422,320	
Sold to local trade, not shipped	291,243		Nevada and Utah	2,526	
Made into coke at mines	1,015,346		New Mexico	22,948	
Shipped to Colorado points	3,386,315		Oklahoma	120,298	
			South Dakota	12,598	
			Texas	[a] 273,337	
			Wyoming	20,984	
Total used in Colorado	4,987,475	58	Total shipped to other States and exported	1,248,990	14
Shipped to other States:					
Arkansas	14,284		Used by railroads	2,388,515	28
California	5,771				
Iowa	12,660		Total production	8,624,980	100
Kansas	340,779				
Missouri	535				

[a] Includes coal exported to Mexico.

ILLINOIS.

The coal fields of Illinois, the third State in rank in the production of coal, are favorably situated in respect to the markets of the middle western territory. Coal was shipped from mines in Illinois to 17 other States, from Ohio on the east to the Dakotas and Nebraska on the west, and from Canada on the north to the Gulf of Mexico on the south. The extent of the sales of coal from Illinois in these States is, of course, determined by the competition offered by coal from other States. Because of the competition of higher-grade coal from the Appalachian fields, little coal from Illinois moves east of Chicago; that shipped to Indiana in 1915, as shown by the accompanying table, was used largely in the district about Chicago, and that reported as shipped to Michigan was probably used in the Upper Peninsula. The coal shipped in 1915 from Illinois to Mississippi, Louisiana, and Texas was about 185,000 tons. The main sources of coal supply in these States are those coal fields of Alabama, Kentucky, and Arkansas that are nearer than the Illinois fields.

It is on the west and northwest that the coal from Illinois finds its largest market. In 1915 Missouri and Iowa consumed more than 7,400,000 tons of Illinois coal, and Kansas and Nebraska, where competition with coal from the Rocky Mountain fields is met, used about 1,350,000 tons of Illinois coal. In Wisconsin, Minnesota, and the Dakotas, 3,000,000 tons of coal from Illinois were used in 1915. It is in this territory that coal from fields to the south, arriving by all-rail routes, meets in competition the coal from Pennsylvania, Ohio, West Virginia, and Kentucky that reaches the head of the Lakes or the lower end of Lake Michigan by water from ports on Lake Erie.

The coal that was both mined and burned in Illinois in 1915 amounted to 26,780,000 tons, or 45 per cent of the output of the State. About 4,000,000 tons of this quantity was used at or near the mines

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and the remainder, 22,780,000 tons, was shipped to points in Illinois. Chicago, which is, of course, the largest coal-consuming center in Illinois, burned about 10,000,000 tons of Illinois coal in 1915. The districts about Peoria and in and around East St. Louis are also large consumers of coal and, with other places, used about 12,000,000 tons of Illinois coal in 1915.

The railroads used nearly 19,000,000 tons, or 33 per cent of the total production, so that in Illinois, as in many other States, the condition of the coal industry depends in no small measure on the prosperity of the common carriers.

Distribution of coal produced in Illinois in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Illinois:			Shipped to other States—Continued.		
Used at mines for steam and heat	1,533,069		Mississippi	96,577	
Sold to local trade, not shipped	2,470,114		Missouri	4,391,722	
Shipped to Illinois points	22,778,530		Nebraska	938,905	
Total used in Illinois	26,781,713	45	North Dakota	106,674	
Shipped to other States:			Ohio	8,036	
Arkansas	128,950		South Dakota	319,370	
Indiana	825,601		Tennessee	68,559	
Iowa	3,053,413		Texas	20,648	
Kansas	414,467		Wisconsin	1,260,188	
Kentucky	6,807		Total shipped to other States (all rail)	13,119,841	22
Louisiana	67,338		Used by railroads	18,928,022	33
Michigan	83,256		Total production	58,829,576	100
Minnesota	1,334,330				

INDIANA.

The three great markets for the coal mined in Indiana are Indiana, Illinois, and the railroads that use it as fuel. In 1915, 38 per cent of the output was consumed within the State, 26 per cent was shipped to others States—nearly all of it to Illinois—and 36 per cent was used by railroads. About 3,000,000 tons of the 4,000,000 tons of Indiana coal consumed in Illinois was used in the Chicago district. Iowa, Wisconsin, and Minnesota received the greater part of the remainder of the coal shipped from Indiana to other States.

Distribution of coal produced in Indiana in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Indiana:			Shipped to other States—Continued.		
Used at mines for steam and heat	425,352		Missouri	12,632	
Sold to local trade, not shipped	547,761		Nebraska	2,833	
Shipped to Indiana points	5,420,906		North Dakota	3,255	
Total used in Indiana	6,394,019	38	South Dakota	3,897	
Shipped to other States:			Tennessee	33	
Illinois	4,044,528		Wisconsin	128,190	
Iowa	149,046		Total shipped to other States (all rail)	4,423,583	26
Kansas	149		Used by railroads	6,188,550	36
Michigan	6,086		Total production	17,006,152	100
Minnesota	72,934				

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IOWA.

The competition offered by coal from other States, particularly that from Illinois, for the market in Iowa and surrounding territory is so strong that the coal operators in Iowa retain with difficulty their share of the market, even in their own State. Only 5 per cent of the output was shipped from Iowa to other States in 1915. More than 4,400,000 tons, or 58 per cent, was used by railroads and about 2,786,000 tons, or 37 per cent of the production, was consumed within the State.

Distribution of coal produced in Iowa in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Iowa:			Shipped to other States—Continued.		
Used at mines for steam and heat	148,159		Missouri	174,164	
Sold to local trade, not shipped	502,286		Nebraska	143,108	
Shipped to Iowa points	2,136,125		South Dakota	24,120	
Total used in Iowa	2,786,570	37	Total shipped to other States	411,741	5
Shipped to other States:			Used by railroads	4,415,832	58
Illinois	17,700		Total production	7,614,143	100
Kansas	40,092				
Minnesota	12,557				

KANSAS.

In Kansas, as in most other States west of the Mississippi, the railroads are the largest consumers of coal. In 1915 more than 3,150,000 tons of coal, or 46 per cent of the production of the Kansas mines, was sold to railroads. For domestic and industrial uses nearly 1,900,000 tons, or 28 per cent of the output, was consumed in the State, and 1,790,000 tons were shipped to other States, the greater part going to Missouri and Nebraska.

Distribution of coal produced in Kansas in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Kansas:			Shipped to other States—Continued.		
Used at mines for steam and heat	184,071		Nebraska	774,937	
Sold to local trade, not shipped	104,531		Oklahoma	75,162	
Shipped to Kansas points	1,591,123		Total shipped to other States (all rail)	1,790,248	26
Total used in Kansas	1,879,725	28	Used by railroads	3,154,501	46
Shipped to other States:			Total production	6,824,474	100
Arkansas	13,669				
Missouri	926,480				

KENTUCKY.

The remarkable advance that has been made in recent years in the production of coal in Kentucky makes interesting a citation of the markets that have been created for the product. There are in reality two separate coal fields in the State. The field in eastern Kentucky is a part of the Appalachian coal region and is properly considered

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with the fields of West Virginia, Pennsylvania, and Tennessee. The field in western Kentucky is a part of the general interior coal region, which includes the fields in Illinois and Indiana. The two fields differ in kind and quality of coal, in mining conditions, and in accessibility to markets and the distribution of the product from the two should be treated separately; but the data available are not of a kind to permit such a distinction.

The best developed markets for the coal from western Kentucky are to the south and southwest, particularly in the Mississippi Valley; the markets for the coal from eastern Kentucky are mainly to the north and northwest. The production of coal in Kentucky in 1915 was 21,361,674 net tons, of which 65 per cent was from the eastern district and 35 per cent from the western district.

Including the coal used at the mines for steam and heat and that made into coke at the mines, about 21 per cent of the total production of the Kentucky mines in 1915, or 4,429,000 tons, was used in the State. About 4,650,000 tons, or 22 per cent of the output, was consumed by railroads, and about 702,000 tons, or 3 per cent of the production, was shipped to the Great Lakes for transshipment by vessel to the northwest.

More than half the production, 11,580,000 tons, was shipped by rail to other States. The rail shipments were made to 25 States, of which Michigan, Ohio, and Indiana received more than 5,300,000 tons. The all-rail shipments to markets in 1915, other than for railroad fuel, in States north of the Ohio and the Potomac and east of the Mississippi were almost 6,631,000 tons; the shipments to States south of the Ohio and east of the Mississippi, other than Kentucky, were about 3,427,000 tons; and the shipments to markets in States west of the Mississippi were more than 1,522,000 tons.

Distribution of coal produced in Kentucky in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Kentucky:			Shipped to other States—Continued.		
Used at mines for steam and heat	495,313		North Dakota	418	
Sold to local trade, not shipped	586,864		Ohio	1,359,813	
Made into coke at mines	458,105		Pennsylvania	[a] 79,126	
Shipped to Kentucky points	2,888,773		South Dakota	89,220	
Total used in Kentucky	4,429,055	21	Tennessee	1,560,776	
Shipped to other States:			Texas	40,112	
Alabama	86,966		Virginia	2,064	
Arkansas	56,913		West Virginia	87	
Florida	17,268		Wisconsin	379,644	
Georgia	800,822		Total shipped to other States	11,580,796	54
Illinois	864,047		Shipped to Great Lakes for cargo	702,000	3
Indiana	2,886,806		Used by railroads	4,649,823	22
Iowa	335,431		Total production	21,361,674	100
Kansas	54,871				
Louisiana	215,007				
Michigan	1,061,640				
Minnesota	345,333				
Mississippi	630,518				
Missouri	478,164				
Nebraska	92,091				
North Carolina and South Carolina	143,660				

[a] Includes Kentucky coal exported by rail to Canada.

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MARYLAND.

The coal from the fields of Maryland is all of high rank, and what is termed the Georges Creek coal is widely known as one of the best blacksmithing coals mined in the country. Shipments by rail, other than for railroad fuel, were made to 17 States and to New England and amounted to nearly 1,900,000 tons, or 45 per cent of the output.

The largest shipments were made to New England (600,000 tons), New York (567,000 tons), and Pennsylvania (506,000). About 10,000 tons of Maryland coal was used on the Pacific coast in California and Washington, and Maryland coal was used in several States in the Mississippi Valley. More than 1,000,000 tons reached tidewater at Baltimore and New York for foreign export, for use as bunker fuel, and for shipment by water to ports in New England States. Only 387,000 tons, or 10 per cent of the output, was used for railroad fuel in 1915.

Distribution of coal produced in Maryland in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Maryland:			Shipped to other States—Continued.		
Used at mines for steam and heat	64,588		Iowa and Kentucky	5,898	
Sold to local trade, not shipped	38,908		Michigan	48,124	
Shipped to Maryland and District of Columbia points	748,673		Missouri and Texas	9,090	
			Montana	58	
Total used in Maryland and District of Columbia	852,169	20	New Jersey	33,561	
			New York	[a] 567,421	
Shipped to other States:			Ohio	37,305	
California and Washington	10,244		Pennsylvania	505,860	
New England	630,097		Virginia	787	
Delaware	9,327		West Virginia	6,525	
Illinois	20,783				
Indiana	6,947		Total shipped to other States (all rail)	1,892,027	45
			Shipped to tidewater	1,049,160	25
			Used by railroads	387,121	10
			Total production	4,180,477	100

[a] Includes small quantity exported to Canada by rail.

MISSOURI.

Missouri is surrounded by coal-producing States and therefore only a small part of its output reaches outside markets. In 1915 only 10 per cent of the coal produced in Missouri was shipped to other States, and the greater part of this was consumed in Kansas and Nebraska. Local markets absorbed 28 per cent of the production in 1915 and the railroads used 62 per cent.

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Distribution of coal produced in Missouri in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Missouri:			Shipped to other States—Con.		
Used at mines for steam and heat	84,091		Oklahoma	4,800	
Sold to local trade, not shipped	201,975		Total shipped to other States	400,237	10
Shipped to Missouri points	773,350		Used by railroads:		
Total used in Missouri	1,059,416	28	Loaded at mine tipples.	190,000	
Shipped to other States:			Shipped	2,161,940	
Arkansas and Illinois	1,888		Total used by railroads	2,351,940	62
Iowa	22,729				
Kansas	167,483		Total production	3,811,593	100
Nebraska	203,337				

MONTANA.

Most of the coal mined in Montana is consumed within the State. The quantity used in 1915 for domestic and industrial purposes and for operating the coal mines was about 59 per cent of the output; that taken by the railroads, also largely consumed within the State, was 38 per cent of the output. The quantity shipped to other States for domestic use and for making steam was but 3 per cent of the output and reached only four States, North Dakota, South Dakota, Washington, and Idaho.

Distribution of coal produced in Montana in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Montana:			Shipped to other States—Continued.		
Used at mines for steam and heat	122,592		North Dakota	44,814	
Sold to local trade, not shipped	105,924		South Dakota	25,702	
Shipped to Montana points	1,410,234		Washington	20,859	
Total used in Montana	1,638,750	59	Total shipped to other States	100,686	3
Shipped to other States:			Used by railroads	1,050,319	38
Idaho	9,311		Total production	2,789,755	100

NEW MEXICO.

The coal fields of New Mexico are scattered over the State and offer to the market a variety of fuels, from the subbituminous coal (black lignite) of the Gallup field to the anthracite in Santa Fe County. In 1915 New Mexico shipped coal to eight States, of which Texas and Arizona were the largest customers. The largest single use of New Mexico coal is for railroad fuel, and in 1915 this consumed 43 per cent of the output. More than 1,000,000 tons, or 28 per cent, of the total production was consumed within the State, mainly for making coke, which, in turn, was shipped to other States for consumption. Small quantities of coal mined in New Mexico were exported by rail to Mexico and were shipped to tidewater at points in Texas on the Gulf of Mexico, where it was used as bunker fuel.

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Distribution of coal produced in New Mexico in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in New Mexico:			Shipped to other States—Continued.		
Used at mines for steam and heat	28,868		Kansas	98,103	
Sold to local trade, not shipped	33,277		Nebraska	339	
Made into coke at mines	734,713		Nevada	135	
Shipped to New Mexico points	259,580		Oklahoma	24,096	
			Texas	313,589	
Total used in New Mexico	1,056,438	28	Total shipped to other States	777,437	20
Shipped to other States:			Used by railroads	1,635,752	43
Arizona	158,273		Exported by rail	155,030	4
California	75,025		Shipped to tidewater	193,283	5
Colorado	107,877		Total production	3,817,940	100

NORTH DAKOTA.

In no other State does the home consumption of coal reach a greater proportion to the total output than in North Dakota. This large home use is due in part to the fact that lignite, the only fuel in the State, is not so desirable as bituminous coal and is therefore not used where better fuel can be obtained, and in part to the tendency of this coal to slack on exposure to the air, so that it can not be shipped for long distances. Small quantities of lignite are used by the railroads for heating their stations and 5,000 tons were shipped in 1915 to South Dakota. The remainder, 98 per cent of the production in 1915, was used within the State.

Distribution of coal produced in North Dakota in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in North Dakota:			Shipped to South Dakota	5,000	1
Used at mines for steam and heat	17,499		Used by railroads	[a] 3,109	1
Sold to local trade, not shipped	151,957		Total production	528,078	100
Shipped to North Dakota points	350,513				
Total used in North Dakota	519,969	98			

[a] For station use.

OHIO.

Ohio uses large quantities of coal and in 1915 ranked fourth in the production of coal. Between 9,000,000 and 10,000,000 tons, or about 43 per cent of the coal produced in Ohio in 1915, was used in the State, so it is evident that the local markets are the most favorable for Ohio coal producers. The railroads used about 7,900,000 tons, or 35 per cent of the output in 1915, and 75,000 tons, or 1 per cent, was shipped to tidewater or exported to Canada by rail. The coal shipped from mines in Ohio to other States in 1915 for use otherwise

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than as railroad fuel amounted to 2,317,036 tons, or 10 per cent of the output in 1915. More than half this quantity went to Michigan and the greater part of the remainder to Illinois and Indiana. Little coal goes from Ohio to market by all-rail routes, except to these three States. Ohio is one of the four States that ship coal to market northwestward by the Great Lakes. The Lake shipments from this State in 1915 were 2,482,615 tons, or 11 per cent of the output.

Distribution of coal produced in Ohio in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Ohio:			Shipped to other States—Con.		
Used at mines for steam and heat	465,701		Minnesota	65,094	
Sold to local trade, not shipped	1,916,188		New York	115,221	
Made into coke at mines	1,217		Pennsylvania	17,075	
Shipped to Ohio points	7,280,390		West Virginia	15,500	
			Wisconsin	10,428	
Total used in Ohio	9,663,496	43.0	Total shipped to other States (all rail)	2,317,036	10.0
Shipped to other States:			Shipped to Great Lakes for cargo	2,482,615	11.0
Illinois	287,561		Exported by rail	60,811	0.9
Indiana	350,251		Shipped to tidewater	15,000	0.1
Iowa	1,666		Used by railroads	7,895,733	35.0
Kentucky and South Dakota	371				
Michigan	1,453,869		Total production	22,434,691	100.0

OKLAHOMA.

More than 2,570,000 tons, or 69 per cent, of the coal mined in Oklahoma in 1915 was used by railroads, and about 722,500 tons of the remainder, or 20 per cent of the output, was consumed in the State. Except that shipped to Texas, 381,000 tons, but little commercial coal from Oklahoma reached outside markets.

Distribution of coal produced in Oklahoma in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Oklahoma:			Shipped to other States—Continued.		
Used at mines for steam and heat	247,565		Missouri	3,653	
Sold to local trade, not shipped	39,482		Texas	381,131	
Shipped to Oklahoma points	435,508		Total shipped to other States	397,275	11
Total used in Oklahoma	722,555	20	Used by railroads	2,573,750	69
Shipped to other States:			Total production	3,693,580	100
Arkansas	453				
Kansas	12,038				

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OREGON.

The only producing coal field in Oregon is on Coos Bay, an arm of the Pacific Ocean, and has no outlet except by water. A small railroad near Coos Bay, the steamships that call at the harbor, and some local industries are the only markets. The coastwise shipments to San Francisco in 1915 were 358 net tons.

Distribution of coal produced in Oregon in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Oregon:			Shipped to tidewater	1,916	5
Used at mines for steam and heat	6,817		Used by railroads	5,000	13
Sold to local trade, not shipped	2,272		Total production	39,231	100
Shipped to Oregon points	23,226				
Total used in Oregon	32,315	82			

PENNSYLVANIA.

The greatest coal-producing State, Pennsylvania, is also the greatest coal-consuming State. Doubtless other factors than the quantity and accessibility of its coal have influenced to some degree the location within its boundaries of the countless industries that now add to its wealth, but it is doubtful whether any other factor has been so potent. In 1915 nearly 60,000,000 net tons of bituminous coal—38 per cent of the output of Pennsylvania in that year—was consumed within the State in making coke and in manufacturing and mining. More than 40,000,000 tons, or 26 per cent of the total, was shipped to other States by rail for uses other than as railroad fuel. About 14,400,000 tons were used in New York, 7,200,000 tons in Ohio, 6,500,000 tons in New England, and nearly 3,500,000 tons in New Jersey. Between 1,000,000 and 2,000,000 tons each were shipped to Maryland, Illinois, and Michigan, and the remainder was used in 25 other States, from the Pacific coast to the South Atlantic States. In 1915 the shipments to the Great Lakes for cargo were more than 9,600,000 tons, or 6 per cent of the output, the shipments to tidewater were 13,960,000 tons, or 9 per cent, and the exports by rail to Canada were 3,866,406 tons, or 2 per cent. Nearly 34,200,000 net tons was used by railroads, of which 3,436,000 tons was consumed in the Great Lakes region and shipped by the Lakes.

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Distribution of bituminous coal produced in Pennsylvania in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Pennsylvania:			Shipped to other States—Continued.		
Used at mines for steam and heat	3,048,515		Nebraska	24,963	
Used at mines for making coke	32,498,370		New England	6,587,390	
Sold to local trade, not shipped	3,231,909		New Jersey	3,489,556	
Shipped to Pennsylvania points	21,214,848		New Mexico	29	
Total used in Pennsylvania	59,993,642	38	New York	14,430,879	
Shipped to other States:			North and South Carolina	305	
Arkansas	86		North Dakota	380	
California	5,324		Ohio	7,197,013	
Colorado	96		Oklahoma	96	
Delaware	951,419		Oregon	126	
District of Columbia and Maryland	1,514,354		Tennessee	30,613	
Idaho	33		Texas	239	
Illinois	1,677,186		Virginia	51,064	
Indiana	855,259		West Virginia	175,000	
Iowa	66,973		Wisconsin	142,694	
Kansas	1,333		Total shipped to other States (all rail)	40,220,496	26
Kentucky	131,101		Shipped to Great Lakes for cargo	[a] 9,619,707	6
Louisiana	478,011		Shipped to tidewater	13,960,000	9
Michigan	1,948,235		Exported by rail	3,866,406	2
Minnesota	120,244		Used by railroads (shipped rail)	[b] 30,294,892	19
Mississippi	45,075		Total production	157,955,137	100
Missouri	294,820				

[a] Includes 3,435,693 tons used for railroad fuel in the northwest.
[b] The total quantity used for railroad fuel was 34,175,299 tons, or 21.6 per cent of the total production.

TENNESSEE.

The coal fields of Tennessee are surrounded by competing fields and a comparatively small proportion of their output reaches markets outside the State. Including coal made into coke but excluding railroad fuel, 1,340,000 tons, or 23 per cent of the output, was used within the State in 1915. The coal shipped to other States amounted to about 1,000,000 tons, or 18 per cent of the output, and that sold for railroad fuel was more than 3,370,000 tons, or 59 per cent of the total production. The "Jellico" coal, mined in northeastern Tennessee, is a favorite domestic fuel in the Southern States. About three-fourths of the coal from Tennessee that is sold in other States went to markets on the south and southeast and the remainder was sold in Indiana, Kentucky, Michigan, Ohio, and Texas. The large percentage of Tennessee coal used by railroads indicates the extent to which the industry in this State depends on the demands of the railroads, and the decline in the production of coal in Tennessee during the last six years is generally attributed to decrease in that demand.

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Distribution of coal produced in Tennessee in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Tennessee:			Shipped to other States—Continued.		
Used at mines for steam and heat	167,560		Indiana	22,590	
Sold to local trade, not shipped	71,071		Kentucky	185,580	
Made into coke at mines	316,138		Michigan	240	
Shipped to Tennessee points	785,968		North Carolina and South Carolina	168,512	
			Ohio	23,974	
			Texas	56,168	
Total used in Tennessee	1,340,737	23	Total shipped to other States	1,014,163	18
Shipped to other States:			Used by railroads	3,375,461	59
Alabama	48,942				
Florida	26,886		Total production	5,730,361	100
Georgia	481,271				

TEXAS.

There is no record that any coal, except, possibly, that used for railroad fuel, was shipped from Texas to other States in 1915. One-half of the output was used by railroads and the greater part of the remainder was consumed within the State. A small quantity was exported to Mexico and 100,000 tons was shipped to tidewater, presumably nearly all for bunker coal for steamships.

Distribution of coal produced in Texas in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Texas:			Exported by rail	78,203	3
Used at mines for steam and heat	59,356		Shipped to tidewater	100,000	5
Sold to local trade, not shipped	13,266		Used by railroads	1,037,249	50
Shipped to Texas points	800,834		Total production	2,088,908	100
Total used in Texas	873,456	42			

UTAH.

The greater part of the coal produced in Utah is used within the State. Including that made into coke, part of which product is, however, shipped to other States, the State used 61 per cent of its own production in 1915. The railroads used a comparatively small part, and, except that shipped to California, Idaho, and Nevada, which are natural markets for coal from Utah, little was used in other States.

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Distribution of coal produced in Utah in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Utah:			Shipped to other States—Continued.		
Used at mines for steam and heat	104,304		Nevada	169,928	
Sold to local trade, not shipped	47,224		Oregon	30,755	
Made into coke at mines	654,387		Washington	32,039	
Shipped to Utah points	1,097,834		Wyoming	50	
Total used in Utah	1,903,749	61	Total shipped to other States	639,477	21
Shipped to other States:			Used by railroads	565,489	18
California	161,987				
Idaho	227,417		Total production	3,108,715	100
Montana	17,301				

VIRGINIA.

The coal produced in Virginia, all of high grade, is widely distributed. One-fourth of the product in 1915 was used in Virginia, in part for making coke; 35 per cent was shipped by rail to 18 other States for domestic and industrial uses, 9 per cent was shipped to tidewater, and 31 per cent was used for railroad fuel.

The largest market for coal from Virginia is in the South. In 1915 more than 2,200,000 tons were shipped to the Carolinas, Georgia, Florida, Alabama, and Tennessee. About 470,000 tons were sold in Michigan, Ohio, Indiana, and Illinois, and 76,891 tons reached States north, northwest, and west of Illinois.

Distribution of coal produced in Virginia in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Virginia:			Shipped to other States—Continued.		
Used at mines for steam and heat	135,799		Minnesota	47,000	
Sold to local trade, not shipped	82,210		Missouri	1,500	
Made into coke at mines	953,352		North Carolina and South Carolina	1,366,943	
Shipped to Virginia points	829,983		North Dakota	15,391	
Total used in Virginia	2,004,344	25	Ohio	169,432	
Shipped to other States:			South Dakota	4,000	
Alabama	67,961		Tennessee	373,244	
Maryland and District of Columbia	3,913		Texas	54,300	
Florida	40,230		Wisconsin	9,000	
Georgia	368,751		Total shipped to other States (all rail)	2,824,961	35
Illinois	120,300		Shipped to tidewater	766,575	9
Indiana	152,291		Used by railroads	2,526,716	31
Iowa	1,500		Total production	8,122,596	100
Michigan	29,205				

WASHINGTON.

Local markets and the railroads together consumed 86 per cent of the coal produced in Washington in 1915. A small quantity—about

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8 per cent of the output—was shipped to Idaho and Oregon, and the remainder was shipped to tidewater. The tidewater movement amounted to 150,071 net tons, of which 12,171 tons was exported to foreign countries, 89,232 tons was used for bunker fuel in the domestic trade, 47,316 tons was used for foreign bunker fuel, and 1,352 tons was shipped by vessel to San Francisco.

Distribution of coal produced in Washington in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Washington:			Shipped to other States:		
Used at mines for steam and heat	126,047		Idaho	25,000	
Sold to local trade, not shipped	64,707		Oregon	172,090	
Made into coke at mines	149,290		Total shipped to other States (all rail)	197,090	8
Shipped to Washington points	592,444		Shipped to tidewater	150,071	6
Total used in Washington	932,488	39	Used by railroads	1,149,446	47
			Total production	2,429,095	100

WEST VIRGINIA.

The coal industry of West Virginia has been developed under unique conditions. There has been little home market, so the operators had to seek markets for their coal in other parts of the United States and in foreign countries. Immense reserves of high-grade coal in easily workable beds have permitted mining on a large scale and at low cost. Proximity to the Atlantic seaboard, where good harbors afford opportunity for foreign and coastwise shipments, and excellent railroad outlets to the markets of the West and Northwest have enabled the coal industry of the State to develop at a rapid rate.

Including the coal made into coke at the mines and that used for steam and heat at the mines, the consumption of West Virginia coal in that State in 1915 was but 6,000,000 net tons, or 8 per cent of the total output. More than 32,500,000 net tons, or 42 per cent of the output, was shipped to other States by rail or by river, for use other than as railroad fuel. The shipments to the Great Lakes for cargo were 8,700,000 net tons, or 11 per cent of the total, and shipments to tidewater were more than 20,400,000 tons, or 27 per cent of the output. The Lake cargo shipments included 800,134 tons for railroad use in the Northwest, and the tidewater shipments included 1,776,419 tons sent by vessels coastwise to New England and used there by the railroads. The quantity of railroad fuel that reached its destination by all-rail routes was 9,478,401 net tons, or 12 per cent of the production in 1915. The total quantity of West Virginia coal used by railroads in 1915 was 12,054,954 net tons, or 15.7 per cent of the total output.

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Distribution of coal produced in West Virginia in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in West Virginia:			Shipped to other States—Continued.		
Used at mines for steam and heat	1,141,178		Nebraska	1,553	
Used at mines for making coke	1,995,279		Nevada	300	
Sold to local trade, not shipped	1,091,371		New Jersey	645,600	
Shipped to West Virginia points	1,772,289		New Mexico	50	
Total used in West Virginia	6,000,117	8	New York	2,072,670	
Shipped to other States:			North and South Carolina	977,782	
Alabama	2,800		North Dakota	425	
Arizona	450		Ohio	5,375,560	
California	17,250		Pennsylvania	4,945,295	
New England	20,419		South Dakota	10,833	
Delaware	245,451		Tennessee	1,305	
District of Columbia and Maryland	814,379		Texas	2,281	
Florida	31,980		Utah	165	
Georgia	41,332		Virginia	2,228,268	
Illinois	5,079,032		Wisconsin	839,105	
Indiana	4,072,001		Total shipped to other States (all rail)	32,555,406	42
Iowa	159,444		Shipped to Great Lakes for cargo	[a] 8,702,172	11
Kansas	390		Shipped to tidewater	[b] 20,405,060	27
Kentucky	443,407		Exported by rail	42,913	0.0
Michigan	4,326,412		Used by railroads (shipped all rail)	[c] 9,478,401	12
Minnesota	40,704		Total production	77,184,069	100
Missouri	158,763				

[a] Includes 800,134 tons used as railroad fuel in the Northwest.
[b] Includes 1,776,419 tons used as railroad fuel in New England.
[c] The total quantity used for railroad fuel was 12,054,954 tons, or 15.7 per cent of the total production.

WYOMING.

The important coal fields of Wyoming are so situated with regard to transportation routes that the coal reaches markets in all adjoining States as well as those in nine distant States, such as Iowa and Missouri. In 1915 coal from Wyoming reached 14 States, and the quantity sold in these States was 1,720,000 tons, or 26 per cent of the output. Montana, Nebraska, South Dakota, Oregon, and Washington received the greater part of the shipments. The largest single market for Wyoming coal is the railroads, which took 65 per cent of the output in 1915, a fact that indicates the extent to which the prosperity of the coal industry of the State is dependent on the prosperity of the great western railroads. There are large possibilities for the coal industry of Wyoming in the home market, which, in 1915, consumed less than 5 per cent of the production.

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Distribution of coal produced in Wyoming in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Wyoming:			Shipped to other States—Con.		
Used at mines for steam and heat	256,932		Montana	594,602	
Sold to local trade, not shipped	71,885		Nebraska	363,418	
Shipped to Wyoming points	280,729		Nevada	44,523	
			North Dakota	96,558	
			Oregon	105,787	
			South Dakota	152,350	
			Utah	74,788	
Total used in Wyoming	609,546	9	Washington	100,277	
Shipped to other States:			Total shipped to other States	1,721,011	26
California	43,546				
Colorado	101				
Idaho	87,619		Used by railroads	4,223,290	65
Iowa	16,418		Exported by rail	151	0.0
Kansas	38,540				
Missouri	1,484		Total production	6,554,028	100

DISTRIBUTION OF PENNSYLVANIA ANTHRACITE.

Pennsylvania anthracite is the fuel most generally used for heating in the United States. Although complete data are lacking, an estimate made from partial statistics showing the purposes for which the anthracite produced in 1915 was used and from statistics showing the quantities of different sizes produced indicates that not less than 50,000,000 net tons of anthracite was used in heating households, apartment houses, hotels, and office, school, and other buildings. About 71,000,000 net tons of bituminous coal was used in the domestic and small steam trade in 1915 (see p. 472), and probably less than 60,000,000 tons of that quantity was used for heating for the comfort of man. Doubtless more persons depend on anthracite than on bituminous coal for heating, for anthracite is used to the greatest extent in the part of the United States that lies north of Virginia and east of western Pennsylvania, a region in which the population is densest and housing most congested. Although its high price and the high cost of transportation make it more or less a luxury in territory farther from its source, anthracite was shipped to nearly every State in the Union, the only exceptions in 1915, according to the reports received by the Geological Survey, being Arizona, Nevada, New Mexico, and Utah. In the territory outside of the New England States, Pennsylvania, New York, and New Jersey, to which more than 80 per cent of the output (including that used by railroads) is shipped for consumption, the States using the greatest quantities of Pennsylvania anthracite are Illinois, where (mainly at Chicago) more than 3,000,000 tons was consumed in 1915, Wisconsin and Minnesota, which obtain their supply almost entirely by way of the Great Lakes, Maryland, and the District of Columbia.

The total shipments to the North Central States were 10,504,000 net tons, of which 4,622,000 tons was sent by way of the Great Lakes and the remainder, 5,882,000 tons, by all-rail routes. Nearly every State in that region received more than 300,000 tons.

The shipments to the South Atlantic and Southern States were 2,161,000 net tons, the greater part of which went to Maryland, the District of Columbia, Delaware, North Carolina, South Carolina, and Virginia. The shipments to that region were made by all-rail routes.

Quantities of anthracite ranging from 200 to 5,000 tons were shipped to the States of the Rocky Mountain and Pacific coast

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regions. The following table shows the distribution of the shipments in 1915:

Distribution of Pennsylvania anthracite in 1915.

	Shipped by way of tidewater (net tons).	Shipped by way of Great Lakes (net tons).	Shipped by rail only (net tons).	Total (net tons).	Percentage of total.
Middle Atlantic States:					
Pennsylvania—					
Used at mines for steam and heat				9,996,544	
Sold to local trade, not shipped				2,092,086	
Shipped to Pennsylvania points			11,203,954	11,203,954	
				23,292,584	
New York			20,789,494	20,789,494	
New Jersey			8,375,000	8,375,000	
			40,368,448	52,457,078	58.9
New England States	5,500,000		8,267,000	13,767,000	15.5
South Atlantic and Southern States:					
Alabama			8,100	8,100	
Arkansas			800	800	
Delaware			210,000	210,000	
District of Columbia and Maryland			1,470,000	1,470,000	
Florida			25,000	25,000	
Georgia			50,000	50,000	
Kentucky			20,000	20,000	
Louisiana			15,000	15,000	
Mississippi			2,000	2,000	
North and South Carolina			124,000	124,000	
Oklahoma			500	500	
Tennessee			9,000	9,000	
Texas			22,000	22,000	
Virginia			170,000	170,000	
West Virginia			35,000	35,000	
			2,161,400	2,161,400	2.4
North Central States:					
Illinois		807,000	2,485,000	3,292,000	
Indiana			600,000	600,000	
Iowa			310,000	310,000	
Kansas			25,000	25,000	
Michigan		45,000	793,800	838,800	
Minnesota		1,600,000	70,000	1,670,000	
Missouri			371,300	371,300	
Nebraska		30,000	497,300	527,300	
North Dakota		310,000	50,000	360,000	
Ohio			600,000	600,000	
South Dakota		150,000	30,000	180,000	
Wisconsin		1,680,000	50,000	1,730,000	
		4,622,000	5,882,400	10,504,400	11.8
Western States:					
California			500	500	
Colorado			600	600	
Idaho			200	200	
Montana			5,000	5,000	
Oregon			200	200	
Washington			1,900	1,900	
Wyoming			200	200	
			8,600	8,600	
Total distributed in United States for purposes other than railroad fuel				78,898,478	
Used for railroad fuel				6,200,000	7.0
Total distributed in United States				85,098,478	
Exported to Canada				3,852,894	
Exported to other countries				112,361	
Total exported				3,965,255	4.4
Total distribution, 1915				89,063,733	100.0
Total production, 1915				88,996,061	

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These statistics were compiled from reports furnished by companies producing, selling, and distributing anthracite and by railroads; from statements given elsewhere in this report, particularly in connection with the reviews of coal trade in large cities; and from reports of the United States Army engineers. For some of the items in the table complete figures were available, but for others estimates were made by the writer, the estimates for some items covering as much as 10 per cent of the quantity reported. The figures showing the tidewater shipments to New England, the consumption by railroads, the all-rail shipments to States, and the shipments by the Lakes to the middle northwest are fairly accurate. The figures showing the distribution among the States of the coal shipped by the Lakes are, however, only approximate. The figures showing exports were taken from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Although used elsewhere in this report (p. 479) to represent consumption, these statistics actually show distribution. The distinction is important, particularly as regards anthracite, because large quantities of it are stored. The anthracite interests reported that during 1915 the piles of stored anthracite were increased by 5,000,000 to 10,000,000 gross tons. The statistics of distribution were obtained from shippers rather than from consumers, and it appears that much coal which has been reported as shipped to certain States, notably to New York, Pennsylvania, New Jersey, and possibly to New England States, in which there are large storage yards, has been consigned to storage, so that the consumption of anthracite in those States was less than the quantity shown in the accompanying table by the number of tons the stocks were increased.

A further element of inaccuracy may be involved in the fact that coal may have been consigned to a storage plant, for instance, in New York State, and so reported to the Geological Survey, and later in the year may have been removed and shipped to other States, but as the production in 1915 was greater than the consumption, and as storage piles were being increased throughout the year rather than cut down, it is not likely that the statistics are greatly affected by this factor.

EXPORTS.

The exports of bituminous coal from the United States in 1915 were 18,776,640 net tons, an increase, compared with 1914, of 3,318,568 tons, or 21 per cent, but less than the exports in 1913, which were 20,145,168 tons. The increase was due to larger shipments to Europe and to South America, as the exports to Canada, the largest user of coal from the United States, decreased about 8 per cent. The bituminous coal shipped to Canada in 1913 was 74 per cent; in 1914, 67 per cent; and in 1915 but 50 per cent of the total exports.

The noteworthy features of the export trade in 1915 were the increasing demand throughout the year from Europe and South America and, in the later part of the year, the scarcity of vessels in which to ship coal to these countries. If the supply of vessels had been adequate the exports undoubtedly would have been much greater.

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Exports of Pennsylvania anthracite decreased from 4,289,873 net tons in 1914 to 3,965,255 net tons in 1915. The exports of anthracite to Canada in 1915 were 3,852,894 net tons, a decrease, compared with 1914, of about 9 per cent.

The following tables have been prepared from the records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce. The statistics show foreign cargo coal only; the quantities of steamship or bunker coal are given elsewhere in this report.

Coal exported from the United States in 1915.

By countries.

	Anthracite.		Bituminous.	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.
Azores, Madeira, etc.			11,882	$29,924
Denmark	95	$510	2,999	8,031
France	220	1,086	251,811	700,443
Greece	1,002	4,939	82,025	219,049
Italy	27,965	131,320	3,283,371	8,679,707
Netherlands			42,800	107,947
Norway			58,830	139,236
Portugal			22,118	60,462
Serbia, Montenegro, etc.			160	460
Spain	1,374	6,417	223,586	615,597
Sweden	4,798	21,420	263,345	625,946
England	1	6	3,809	12,566
Ireland	358	1,660	700	2,125
Bermuda	2,885	11,733	30,161	83,215
British Honduras			429	1,336
Canada	3,852,894	17,935,407	9,356,872	17,701,164
Costa Rica	85	503	25,133	56,732
Guatemala	48	309	16,264	38,390
Honduras	60	551	20,558	53,177
Nicaragua			1,074	3,443
Salvador	7	52	26	230
Greenland			897	2,203
Panama	671	3,779	577,182	1,400,881
Mexico	757	4,634	312,495	1,237,153
Miquelon, etc.	607	2,942		
Newfoundland, etc.	14,020	63,315	2,518	7,284
Barbados	195	1,205	98,285	267,225
Jamaica	249	1,481	49,528	132,597
Trinidad, etc.	288	1,516	97,772	279,452
Other British West Indies	672	3,222	119,705	317,253
Cuba	37,679	141,997	1,305,776	3,274,890
Danish West Indies			29,630	83,112
Dutch West Indies	209	1,075	63,050	170,133
French West Indies			95,150	263,002
Haiti	40	266	797	2,263
Dominican Republic	8,709	40,542	15,043	47,709
Argentina	2,830	15,493	881,403	2,378,381
Brazil	2,705	9,518	726,089	1,942,088
Chile	1,089	5,451	80,117	209,441
Colombia	177	986	4,425	10,879
British Guiana	114	682	22,549	62,214
Dutch Guiana			7,862	21,996
Peru	199	1,194	16,681	42,210
Venezuela	1,496	10,246	9,456	27,287
Equador			6,741	16,504
Uruguay	678	3,867	177,185	463,208
British West Africa			12,264	29,215
Dutch East Indies			18,101	47,279
Canary Islands	21	145	26,862	71,504
Egypt			178,436	487,066
French Africa			123,206	333,195
Morocco			7,233	17,906
Portuguese Africa	1	8	12,138	32,509
Australia	48	278		
Other British Oceania			11	113
	3,965,255	18,429,255	18,776,640	42,817,341

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Coal exported from the United States in 1915—Continued.

By customs districts.

	Anthracite.		Bituminous.	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.
Hawaii			11	$113
Maine and New Hampshire	10,641	$53,613	120	586
Maryland	3,533	17,778	2,129,642	5,549,472
Massachusetts	1,259	7,849	160	710
New York	220,931	991,226	37,092	116,513
Philadelphia	96,846	401,421	1,166,858	3,045,222
Porto Rico			1,995	11,259
South Carolina			7,293	19,537
Virginia	690	4,069	5,804,787	15,240,981
Florida	422	1,897	1,909	6,205
Mobile	72	568	6,599	18,212
New Orleans	215	1,200	12,132	39,471
Sabine	103	640		
Arizona	2	30	33,188	108,203
Eagle Pass			524	2,000
El Paso			196,020	876,033
Laredo			23,502	83,542
San Francisco	7	85	479	4,076
Southern California	67	729	286	2,221
Washington	85	594	12,171	36,343
Buffalo	1,859,892	8,622,277	2,485,631	4,995,579
Dakota	15,688	96,830	43,602	113,713
Duluth and Superior	8,453	46,820	43,119	108,081
Michigan	303	943	613,377	1,035,526
Ohio	64,419	296,003	5,204,817	9,347,791
Rochester	606,631	2,933,440	645,671	1,457,323
St. Lawrence	1,063,904	4,902,695	300,418	590,036
Vermont	12,092	48,548	5,150	7,408
Alaska			87	1,185
	3,965,255	18,429,255	18,776,640	42,817,341

Coal exported from the United States, 1910–1915.

	Anthracite.		Bituminous.	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.
1910	3,384,222	$14,785,387	12,078,348	$26,685,405
1911	3,980,479	18,093,285	15,544,204	34,499,989
1912	4,131,444	19,425,263	16,195,175	36,817,633
1913	4,652,912	21,959,850	20,145,168	45,449,664
1914	4,289,873	20,211,072	15,458,072	34,104,903
1915	3,965,255	18,429,255	18,776,640	42,817,341

The following table shows the exports of bituminous coal according to the States in which it was produced. The data from which the table has been compiled are not complete, particularly as regards the division between Pennsylvania and West Virginia, but the figures are the best that are available.

The exports from Alabama and Washington are shipped from tidewater points, and the exports from Colorado, Kentucky, New Mexico, Texas, and North Dakota are shipped by all-rail routes to Canada and Mexico. A small quantity of the exports from Maryland was shipped by rail to Canada and the remainder by vessel from Baltimore. The exports from Ohio were shipped mainly by way of the

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Great Lakes and are included in the Lake cargo shipments from the State shown elsewhere in this report. A small quantity of Ohio coal was exported to Canada by rail. The coal exported from Pennsylvania was shipped by vessel from the harbors at New York, Philadelphia, and Baltimore, and the harbors on Lake Huron and Lake Erie, by rail to Canada through Buffalo and, to a small extent, from points in New England. The greater part of the coal exported from West Virginia and Virginia was loaded on vessels at Hampton Roads, a small quantity was loaded on vessels at Baltimore, and about 43,000 net tons was shipped to Canada by rail. About 2,000,000 tons of coal was shipped from West Virginia to Canada by way of the Great Lakes, either directly to Canadian points by vessel, or by rail from the head of the Lakes. The exports from Virginia were loaded on vessels at Charleston, S. C., and Hampton Roads, Va.

Bituminous coal exported from the United States, 1915.

	Net tons.		Net tons.
Alabama	23,641	Washington	12,171
Colorado and Kentucky	93,645	West Virginia and Virginia	8,951,844
Maryland	515,538	Wyoming	181
New Mexico	155,030	Unspecified[1]	2,858
Ohio	663,811		
Pennsylvania	8,279,718		18,776,640
Texas	78,203		

IMPORTS.

The imports of both bituminous coal and anthracite into the United States are small. The largest markets for foreign coal in this country are the New England States, the northwest States bordering on Canada, and California. Coal from Nova Scotia is used in New England and coal from Vancouver Island and Alberta is used in the Northwest. The figures in the following tables were compiled from the records of the Bureau of Foreign and Domestic Commerce, of the Department of Commerce.

The total imports of bituminous coal in 1915 were 1,709,205 net tons, of which 654,703 tons, or 38 per cent, was entered in New England; $432,721 tons, or 25 per cent, was entered in Montana and Idaho; and 413,225 tons, or 24 per cent, was received at Pacific coast ports. Imports of bituminous coal at Hawaii were 160,330 tons, and at Alaska 29,457 tons.

Bituminous coal imported into the United States in 1915.

Customs district.	Quantity (net tons)	Value.	Customs district.	Quantity (net tons).	Value.
Alaska	29,457	$124,873	New York	12,176	$37,238
Buffalo	1,319	3,544	Oregon	793	2,647
Dakota	1,626	1,807	Philadelphia	991	4,485
Florida	515	1,955	San Francisco	274,564	767,377
Galveston	392	1,650	Southern California	9,661	30,894
Hawaii	160,330	378,499	Vermont	9,427	24,790
Maine and New Hampshire	143,823	310,930	Virginia	661	875
Maryland	252	773	Washington	128,207	476,140
Massachusetts	501,443	1,189,326		1,709,205	4,410,772
Michigan	837	1,712			
Montana and Idaho	432,721	1,031,257			

[1] Includes exports reported by the Bureau of Foreign and Domestic Commerce from the districts of Porto Rico, Hawaii, San Francisco, southern California, and Alaska.

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Anthracite imported into the United States in 1915.

Customs district.	Quantity (net tons).	Value.
Maine and New Hampshire	24	$160
Michigan	48	239
Oregon	661	3,047
Vermont	49	580
Washington	32	198
	814	4,224

Coal imported and entered for consumption in the United States, 1910–1915.

	Anthracite.		Bituminous.	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.
1910	9,180	$42,244	2,224,609	$4,761,223
1911	2,759	12,550	1,383,198	3,604,797
1912	1,870	8,329	[a] 1,798,578	4,509,066
1913	1,004	5,620	[a] 1,582,557	3,853,930
1914	17,696	25,380	[a] 1,545,828	3,902,881
1915	814	4,224	[a] 1,709,205	4,410,772

[a] Includes 510,257 net tons of slack or culm (value, $901,051) passing ½-inch screen in 1912; 394,248 tons (value, $689,864) in 1913; and 184,433 tons (value, $303,348) in 1914; and 232,891 tons (value $491,731) in 1915.

CONSUMPTION OF BITUMINOUS COAL AND LIGNITE, BY INDUSTRIES, ACCORDING TO SOURCES.

GENERAL STATEMENT.

The coals produced in the United States are of many kinds and are used for many purposes. Certain kinds are in demand for particular uses, as cannel coal for open fireplaces, Cumberland or Georges Creek for blacksmithing, and Connellsville for coking in beehive ovens. West Virginia splint and Jellico (Tennessee) coals are well known as domestic fuels, and Pocahontas and Somerset as steam coals. The physical and particularly the chemical properties of a coal now largely determine the use for which it is adapted, although not all the old-time prejudices of the consumer have yet been overcome by the advance of modern ideas on the scientific purchase and utilization of coal. The quantities of coal from each State used for different purposes are shown in the accompanying table, which, however, indicates only the more important uses and those for which statistics are available. Small quantities of bituminous coal are used as blast-furnace fuel, as reduction material in zinc smelting, in the chemical and electrochemical industries, in pulverized form for foundry facing, and in other ways.

Bituminous coal is, of course, used principally for steam raising. The coal used by industrial steam plants, by railroads, by steamships, by the coal mines, and exported amounted to about 305,000,000 tons, or 70 per cent of the production in 1915, all used for making steam. Of that quantity, about 144,000,000 tons, or 33 per cent of the total, was used by industrial steam plants and presumably for all general purposes in the industries, as in making producer gas and burning

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cement, and 122,000,000 net tons, or 28 per cent of the total, was consumed by the railroads. More than 71,000,000 tons, or 16 per cent of the output of bituminous coal, was taken by the domestic and small-steam trade and used for heating dwellings, apartment houses, hotels, and office buildings, and for heating and steam raising in small power plants.

The distinction between industrial steam trade and domestic and small-steam trade is, of course, largely arbitrary. The statistics given in the following table are based on figures or estimates furnished by the producing companies and the selling or distributing agents, most of whom, however, were not able to show exactly the division of their product between these classes of use, because before it reached the consumers the coal was in turn handled by brokers and wholesale and retail dealers.

In order of magnitude as a consumer of bituminous coal, the coke industry ranks third, more than 61,500,000 tons, or 14 per cent of the output, having been used in 1915 in making coke. About 4 per cent was exported, 2 per cent was used at the coal mines for generating steam and heat, and 1 per cent was used in making coal gas for municipalities. Special industries, such as blacksmithing, used 714,000 tons, or about 0.1 per cent.

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Distribution of bituminous coal and lignite produced in the United States and imported, 1915, by uses.

State in which coal was produced.	Railroad fuel.		Steamship bunker fuel—Tidewater.[a]		Steamship bunker fuel—Great Lakes.[b]		Manufacture of beehive coke.		Manufacture of by-product coke.		Manufacture of coal gas.[c]	
	Quantity (net tons).	Per cent.	Quantity (net tons).	Per cent.	Quantity (net tons).	Per cent.	Quantity (net tons).	Per cent.	Quantity (net tons).	Per cent.	Quantity (net tons).	Per cent.
Alabama	5,072,435	4.0	480,258	5	.....	.....	1,708,228	4.0	2,987,710	15.1	109,160	2.4
Alaska	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arkansas	803,295	.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
California[d]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Colorado	2,388,515	2.0	.....	.....	.....	.....	1,026,019	2.3	.....	.....	103,674	2.3
Georgia	5,000	.0	.....	.....	.....	.....	35,377	.1	.....	.....	.....	.....
Illinois	18,928,022	16.0	.....	.....	.....	.....	.....	.....	98,073	.5	34,785	.7
Indiana	6,188,550	5.0	.....	.....	.....	.....	.....	.....	.....	.....	60,145	1.3
Iowa	4,415,832	3.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Kansas	3,154,501	2.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Kentucky	4,649,823	3.8	.....	.....	11,879	1	462,168	1.0	1,546,834	7.9	616,936	13.5
Maryland	387,121	.3	76,044	1	.....	.....	.....	.....	156,782	.8	21,000	.5
Michigan	394,921	.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Missouri	2,351,940	2.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Montana	1,050,319	1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
New Mexico	1,635,752	1.3	.....	.....	.....	.....	732,830	1.7	.....	.....	11,187	.2
North Dakota	3,109	.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ohio	8,206,128	6.7	.....	.....	216,760	15	.....	.....	.....	.....	.....	.....
Oklahoma	2,573,750	2.0	.....	.....	.....	.....	.....	.....	.....	.....	9,553	.2
Oregon	5,000	.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pennsylvania	34,175,299	28.0	5,888,708	64	1,009,484	69	33,972,018	81.0	6,421,707	32.8	2,497,216	55.0
South Dakota	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tennessee	3,375,461	2.7	.....	.....	.....	.....	433,781	1.0	32,084	.2	62,020	1.3
Texas	1,037,249	.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Utah	565,489	.5	.....	.....	.....	.....	654,387	1.4	.....	.....	49,615	1.0
Virginia	2,826,716	2.0	(e)	.....	.....	.....	995,396	2.2	.....	.....	99,149	2.1
Washington	1,149,446	1.0	.....	.....	.....	.....	158,496	.3	46,383	.2	124,093	2.7
West Virginia	12,054,954	10.0	[f] 2,800,904	30	223,470	15	2,099,816	5.0	7,774,809	40.0	765,046	16.8
Wyoming	4,223,290	3.4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Imports[g]	[h] 378,083	.3	.....	.....	.....	.....	.....	.....	[h] 490,000	2.5	.....	.....
	122,000,000	100.0	9,245,914	100	1,461,593	100	42,278,516	100.0	19,554,382	100.0	4,563,579	100.0
Percentage of total consumption	28.0	.....	2.0	.....	0.3	.....	9.3	.....	4.3	.....	1.0	.....

[a] Includes coal for foreign and domestic bunker at ports only of New York, Philadelphia, Baltimore, Hampton Roads, New Orleans, Mobile, and Pensacola, and Georgia and South Carolina ports.

[b] Includes only vessel fuel taken on at Lake Erie ports, exclusive of Buffalo.

[c] Does not include 81,216 tons the origin of which is not known. The total coal used in the manufacture of coal gas was 4,644,795 tons.

[d] Includes Idaho and Nevada.

[e] Included with West Virginia.

[f] Includes Virginia.

[g] Does not include 841,122 net tons imported, the use of which is not known.

[h] Estimated.

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Distribution of bituminous coal and lignite produced in the United States and imported, 1915, by uses—Continued.

State in which coal was produced.	Domestic and small steam trade.		Industrial steam trade.[a]		Exported.[b]		Used at mines for steam and heat (net tons).	Special uses (net tons.)[c]	Total quantity (net tons).
	Quantity (net tons).	Per cent.	Quantity (net tons).	Per cent.	Quantity (net tons).	Per cent.			
Alabama	1,592,932	2.2	2,389,397	1.7	23,641	0.1	535,340	28,836	14,927,937
Alaska	1,400	.0							1,400
Arkansas	622,734	.9	110,012	.1			62,175	53,890	1,652,106
California[d]	12,203	.0					300		12,503
Colorado	2,350,000	3.3	2,365,019	1.6	[e] 93,645	.5	294,571	3,537	8,624,980
Georgia	6,084	.0	80,335	.1			7,200		134,496
Illinois	17,206,032	24.1	21,020,595	14.7			1,533,069		58,829,576
Indiana	2,789,631	4.0	7,542,334	5.3			425,352	140	17,006,152
Iowa	1,600,763	2.2	1,449,389	1.0			148,159		7,614,143
Kansas	2,203,200	3.1	1,239,302	.8			184,071	43,400	6,824,474
Kentucky	7,148,651	10.0	6,339,370	4.4	(f)		495,313	90,700	21,361,674
Maryland	86,575	.1	2,799,231	2.0	515,538	2.8	64,588	73,598	4,180,477
Michigan	500,498	.7	225,000	.1			35,719		1,156,138
Missouri	1,072,940	1.5	302,622	.2			84,091		3,811,593
Montana	1,212,613	1.7	404,231	.3			122,592		2,789,755
New Mexico	600,000	.8	598,617	.4	155,030	.8	28,868	55,656	3,817,940
North Dakota	448,234	.6					17,499	59,236	528,078
Ohio	3,993,510	5.6	8,888,781	6.0	663,811	3.5	465,701		22,434,691
Oklahoma	585,787	.8	275,665	.2			247,565	1,260	3,693,580
Oregon	27,414	.1					6,817		39,231
Pennsylvania	9,362,300	13.0	53,055,847	37.0	8,279,718	44.2	3,048,515	243,825	157,955,137
South Dakota	10,593	.0							10,593
Tennessee	746,755	1.1	912,700	.6			167,560		5,730,361
Texas	814,100	1.1	100,000	.1	78,203	.4	50,356		2,088,906
Utah	1,127,210	1.6	606,960	.4			104,304	750	3,108,715
Virginia	(g)		(g)		(g)		135,799	59,245	8,122,596
Washington	333,000	.5	479,459	.3	12,171	.1	126,047		2,429,095
West Virginia	[h] 13,159,720	18.5	[h] 32,218,619	22.5	[h] 8,951,844	47.6	1,141,178		77,184,069
Wyoming	1,721,110	2.5	352,515	.2	181	.0	256,932		6,554,028
Imports[i]									868,083
Percentage of total consumption	71,336,489 16.0	100.0	143,765,500 33.0	100.0	18,773,782 4.0	100.0	9,798,681 2.0	714,073 .1	443,492,509

[a] Includes also fuel coal for river steamers and all bunker supplies for lake and ocean vessels other than given elsewhere in this table.
[b] Does not include 2,858 net tons reported by the Bureau of Foreign and Domestic Commerce as exported from Porto Rico, Hawaii, San Francisco, southern California and Alaska.
[c] Blacksmithing coal mainly.
[d] Includes Idaho and Nevada.
[e] Includes exports by rail from Kentucky.
[f] Included in exports from Colorado.
[g] Included with West Virginia.
[h] Includes Virginia.
[i] Does not include 841,122 net tons imported, the use of which is not known.

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COAL USED BY RAILROADS.

In 1915 the railroads in the United States used 128,200,000 net tons of bituminous coal and anthracite, or 24 per cent of the output. The quantity of bituminous coal so used was 122,000,000 tons, or 28 per cent of the bituminous output, and the quantity of Pennsylvania anthracite used was 6,200,000 tons, or 7 per cent of the anthracite output. Of that quantity 56,500,000 tons of bituminous coal and all of the anthracite (6,200,000 tons), or 49 per cent, was used by roads in the northeastern part of the country, 22,000,000 tons of bituminous coal, or 17 per cent, was used in the Southern States, and 43,500,000 tons, or 34 per cent, was used in the West.

These statistics were compiled from reports made to the Geological Survey by more than 180 roads of Class I—defined by the Interstate Commerce Commission as roads whose annual gross operating revenues exceed $1,000,000—and from data furnished by many other roads. From information supplied by the railroads showing the quantities of coal used, and from statistics furnished by the Interstate Commerce Commission covering the number of steam-locomotive miles operated, an average consumption of coal per locomotive mile was determined for each district, on the basis of which average estimates were made of the fuel consumed by such of the larger roads as did not report and by all the small roads. The quantity thus estimated was less than 5 per cent of the total. Corrections were made, of course, for miles run electrically and for operations using fuel oil. A check on these figures—only a partial check in some districts—was furnished by the returns received from coal operators and distributors who reported the quantity of their product sold to railroads.

The information requested of the railroad companies included the quantity of coal used and the States or coal fields in which the coal was mined. It is obviously impracticable to show the States in which the railroad fuel was consumed. The following table shows the quantity of railroad fuel received from each State, the district in which it was used, and the total consumed in each district. The districts are those defined by the Interstate Commerce Commission as follows:[1]

For the purposes of this report, the railway companies listed have severally been assigned to three so-called districts, which are defined below. These districts correspond in a general way to the territories covered by the three general freight classifications in use throughout the United States, namely, the official, the southern, and the western.

The eastern district comprises that portion of the United States bounded on the west by the northern and western shore of Lake Michigan to Chicago, thence to Peoria, thence to East St. Louis, thence down the Mississippi River to the mouth of the Ohio River; and on the south by the Ohio River from its mouth to Parkersburg, W. Va., thence to the southwestern corner of Maryland, thence by the Potomac River to its mouth.

The southern district comprises that portion of the United States bounded on the north by the eastern district and on the west by the Mississippi River.

The western district comprises the remainder of the United States, except Alaska and island possessions.

The assignment of carriers to the several districts is necessarily arbitrary in those cases in which carriers operate in more than one of them. The order in which the statistics for the carriers in each district are presented depends upon their rank with respect to operating revenues.

[1] A preliminary abstract of statistics of common carriers for the year ended June 30, 1914, p. 5, Interstate Commerce Commission, 1915.

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COAL—PART B, DISTRIBUTION AND CONSUMPTION.

By C. E. LESHER.

INTRODUCTION.

OBJECT AND SCOPE OF REPORT.

The object of this report is to furnish statistics showing the internal distribution of the coal produced in the United States, the principal purposes for which it is used, and the quantities consumed in each State. For 34 years the Geological Survey has collected and published the statistics of the production and value of coal, but this is the first comprehensive investigation made to show in detail where the coal produced is consumed. The competition between the bituminous coal-producing districts in the United States for the domestic markets is as active as that between the coal-exporting nations of the world for the foreign markets. The extent and nature of the demand in the domestic markets are moveover of ever-present interest to our coal industry, because more than 95 per cent of the coal produced in the United States is used within the country.

The largest problem confronting the exploiters of a coal deposit is, of course, that of markets, and whoever produces or sells the coal must consider in a broad way the possible markets not only as to quantity but as to quality. For blacksmithing and for making coal gas, coals that have special chemical and physical properties are required, and domestic users have established preferences based on both experience and prejudice. By far the largest part of the coal supplied to every market is used for raising steam, and the statistics of coal used for this purpose in any and every part of the country are therefore of primary interest to those who are engaged in the coal industry. The limitations of time and funds available for the work on this report have permitted only incidental consideration of the markets for bituminous coals of particular kinds. The distribution of coal from West Virginia, for instance, is shown for the State as a unit, though there is a great difference between the kinds of coal mined there and as great a difference between the markets reached by the coal.

The cost of mining, the largest element of which—the cost of labor—is now practically controlled either directly or indirectly by the labor unions, and the cost of transportation, regulated by the Government through the Interstate Commerce Commission, impose definite limitations upon the markets that may profitably be reached by any coal. It is fast becoming the rule that the deciding factor in the purchase of coal for most uses is its cost in terms of the work to be performed. The large user of steam coal in Michigan makes

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his contract for coal from Kentucky, Ohio, Pennsylvania, or West Virginia, according to his requirements, after he has determined which coal will evaporate a given quantity of water at the least cost.

The pioneers in the large developments in the eastern Kentucky coal fields within the last few years no doubt took counsel as to the extent and possible future of the markets within reach of that coal, even before they equipped mines and built railroads, and any expectations they may have entertained regarding the possibility of successfully invading the markets of the Great Lakes region appear to have been fully justified. A study of the history of production in eastern Kentucky and of that of the coal fields of Ohio, Pennsylvania, and West Virginia, with which Kentucky comes into competition, would not alone have sufficed, however, to enable them to foretell this. It was equally essential to know the extent to which the different fields were sharing the markets, and whether the consumption of coal in the Lake region was increasing and at what rate.

Statistics of the movement of coal to market are of particular interest to those who are considering railroad rates. The quantity of coal carried by the railroads is larger than that of any other single commodity, and it is the coal traffic that has made possible the profitable operation of a number of important railroads. It is to the interest of the coal-carrying roads, within the limits of fair play, to keep in balance the movement from the competing fields. Here, again, data of the kind given in this report are needed as a basis of intelligent action.

METHOD OF COMPILING AND LIMITS OF ACCURACY IN THE STATISTICS.

Great accuracy can be attained in the statistics of the production of coal, for the reason that the number of producers, though large, is not so great as to prevent a comparatively complete canvass for reports. As the information is obtained at the source of the product the accuracy of the final figures is limited only by the thoroughness of the canvass and the care with which the individual producers have supplied the data. The best source of information on actual consumption is, of course, the consumer, but the attempt to collect such figures from consumers would be little short of that of taking a census of the country—an attempt that obviously can not be made by the Geological Survey. In this investigation data showing the destination of the coal produced were collected from all attainable sources and all the coal that was reported to be shipped to any State was assumed to represent the consumption in that State. As will be shown, this assumption is not necessarily true, but the limitations being recognized, the results may be accepted as showing consumption as closely as it can be ascertained.

The blank forms sent to the operators at the end of 1915 asking for their reports of production requested also a general statement showing the distribution of the product. The replies indicated that most of the smaller operators have no available records giving the destination of their shipments, for the reason that their coal, in part at least, is distributed by the selling agencies of the larger producing companies, by brokers, or by other middlemen. A list of companies

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and individuals engaged in selling and distributing coal was then prepared, and requests were sent to them for information regarding the quantities of coal they handled in 1915 from each producing State, the company or companies that sold them the coal, and the destination of the product. Figures or estimates were also requested covering the several uses for which the coal was sold, namely, (1) domestic and small steam trade, (2) industrial steam trade, (3) coke and coal gas manufacture, (4) railroad fuel, and (5) special uses, as for blacksmithing.

The reports on distribution covered deliveries (1) to tidewater, (2) to the Great Lakes for cargo, (3) to railroads for fuel, and (4) to individual States or to Canada and Mexico by rail. The statistics of the production of each company already available in the Survey afforded a practical check on the reports. Although the statistics furnished by the operators did not show in full the shipments to all individual States, the quantity reported for a number of the States was practically complete.

In order to obtain full statistics of the consumption of coal by railroads, the railroad companies were requested to report the quantity of coal used in 1915 and the States in which the coal was mined. The statistics thus collected are used throughout this report and are discussed in detail on pages 473–474. Statistics of bituminous coal shipped to the Great Lakes for cargo and of fuel coal supplied to vessels on Lake Erie were compiled by the Ohio Bureau of Coal Statistics. Statistics of receipts and shipments from tidewater were compiled from records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce, from reports furnished by the railroads over which the coal was delivered to tidewater, from reports of United States Army engineers, and from figures and estimates furnished to the author by persons familiar with this movement.

The total quantity of coal shipped from the mines in each producing State to points within that State and in other States by rail or by river was obtained by subtracting from the total shipments of each State, as reported by the operators and as shown in Part A of this report, the coal supplied to railroads, shipped to the Great Lakes for cargo, shipped to tidewater,[1] and exported to Canada and Mexico by rail. The information compiled from reports furnished by operators, distributors, and others, to show the destination of coal by States, was used to show the distribution of this interior rail movement. Incomplete figures were supplemented by estimates obtained by the author from reliable sources by personal visits to trade centers in the East and the Middle West. The statistics compiled by the Illinois-Indiana Coal Traffic Bureau, the Ohio Bureau of Coal Statistics, and the St. Louis Coal Traffic Bureau were of special value in completing the figures for Illinois, Indiana, Ohio, and Missouri.

The possibility of duplication in the figures submitted, through the same coal having been handled by more than one individual or company making reports to the Geological Survey, was recognized. In preparing the data for tabulation care was taken to eliminate all apparent duplication, and in doubtful instances to obtain supple-

[1] Coal shipped to tidewater at New York Harbor but used in the city of New York is not included in the tidewater figures in this report. See p. 501.

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mental statements from the companies. Many of the Survey's correspondents voluntarily gave information as to the possibiliy of duplication and in many ways rendered valuable assistance that was not specifically requested.

The final results of such an investigation as this can not, of course, be more accurate than the items from which they are compiled. Not all the companies were able to furnish exact figures in the form requested. A few of them—10 to 15 per cent of those reporting—supplied estimates based on their records of cars shipped and the value of product sold in different markets, or, for some items, merely upon their general knowledge of the year's business.

The quantities of coal used by railroads and consumed in the manufacture of coke and coal gas were obtained from the reports of the users and are, of course, as accurate as they can be made. Likewise the statistics of exports, imports, and foreign bunker fuel are official figures, and there can be no question as to the completeness and accuracy of the data on lake cargo shipments, prepared by the Ohio Bureau of Coal Statistics.

Operators or their agents not uncommonly ship coal to such centers of traffic as Buffalo or Chicago on consignment and to the order of a broker or another company. So far as the records of the original shipper are concerned, Buffalo or Chicago is the destination of that coal, whereas it was probably reconsigned and shipped to market at some other point, near or distant. Some of those who reported shipments of this character were able also to supply estimates showing the final destination of the coal; others gave the names of the consignees, from some of whom further data were collected by the Survey. A condition so complex made the accuracy of some of the reports received doubtful, and the doubt could be removed only by a volume of correspondence that would probably have overtaxed the patience of the officials of the companies that supplied the information.

On the assumption, therefore, that all coal produced was distributed, it appears that any inaccuracy in the statistics given in this report will lie mainly in the records of shipments to States. Although the plan adopted may appear to assume greater accuracy than can be claimed, the total coal distributed from each State has been balanced with the total production, the quantities being shown to the nearest ton, though they are not accurate to that degree.

UNIT OF MEASUREMENT.

The net ton of 2,000 pounds has been used uniformly throughout this report, for a common unit was necessary throughout the tables in order that quantities might be compared with ease. Except in Maryland, West Virginia, and parts of Pennsylvania most of the coal operators use the net ton. The statistics for Pennsylvania anthracite and of bituminous coal shipped for export and of coastwise and bunker fuel at tidewater were reported in gross tons but were converted to net tons for use in the report. Although the gross ton is commonly used by railroads and other transportation companies in the territory near the Atlantic coast, the net ton is used in the retail trade throughout a large part of that region for both bituminous coal and anthracite.

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ACKNOWLEDGMENTS.

The author wishes to acknowledge with thanks and appreciation the hearty cooperation of the many operators, selling agents, brokers, and others whose detailed reports, many of them prepared at considerable expense, furnish the foundation for these statistics. Thanks are also extended to the officials of railroads, to the district officers of the Corps of Engineers of the United States Army, to commercial organizations, and to the many individuals whose willing assistance has been of value in the work of compiling these figures. Wherever possible throughout the report special mention and credit have been given for data furnished. Grateful acknowledgment is also made to Miss Lida Mann, Miss R. M. McKinney, and others of the Geological Survey for valuable clerical assistance in preparing the figures for publication, and to Mr. J. A. Dorsey, also of the Survey staff, who compiled the statistics of exports and bunker coal from the records of the Bureau of Foreign and Domestic Commerce.

DISTRIBUTION OF BITUMINOUS COAL AND LIGNITE.

GENERAL FEATURES.

The statistics collected from the operators of coal mines and published in Part A of this report show the quantities of bituminous coal and lignite (1) used at the mines for generating steam and heat, (2) sold locally or used by employees, (3) used at the mines for making coke (none of this coal is shipped), and (4) shipped to market, either by rail or by river. The destination and use of the coal embraced in the first three items are thus recorded, but a special investigation was necessary to determine the destination and use of the coal shipped, which forms 86 per cent of the quantity produced.

Coal reaches the market by three general methods of transportation—(1) all-rail, with which in this report are included the shipments by rivers; (2) rail to tidewater, thence to vessel to foreign markets (exports) or by vessel to other points on the coasts of the United States or its insular possessions (coastwise), or used at tidewater points for fuel on steamships (bunker); (3) rail to the Great Lakes, notably to lower Lake ports on Lake Erie, thence by boat to upper Lake ports on Lake Superior or Lake Michigan or to Canada, and from upper Lake ports again by rail to markets in the interior.

One of the purposes of this investigation was to ascertain the quantity of coal consumed in each State for domestic and industrial uses as distinguished from that consumed by railroads and in the manufacture of coke and coal gas. Statistics collected from the manufacturers of coke and coal gas[1] showed the quantity of coal consumed in those industries, and statistics obtained directly from the railroad companies (see pp. 473–474) showed the quantity consumed by the railroads. It was not considered practicable to attempt to ascertain the quantities of coal consumed by railroads within individual States, so the quantity thus used, which is distributed by all

[1] See reports on coke and on artificial gas and by-products in 1915 in other chapters of Mineral Resources.

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three methods of delivery, is shown separately in the accompanying table and throughout the report.

The all-rail movement, which, as has been explained, includes shipments by rivers, is separated into (1) shipments to points within the State in which the coal was mined, with which, for convenience, are included quantities not shipped, used at the mines for steam and heat, and used locally and by employees at the coal mines; (2) shipments to other States; (3) quantities used by railroads serving the coal fields or delivered by them to other railroads; and (4) exports to Canada and Mexico by rail. The details of the shipments to other States and of the tidewater and lake movements are given in succeeding tables.

DISTRIBUTION BY ALL-RAIL ROUTES.

About 96 per cent of the coal produced in the United States is used in this country, and 86 per cent of the total output in 1915 reached the point of consumption by rail. The States in which the coal is mined are the largest users of fuel, and 33 per cent of the output of bituminous coal in 1915 was consumed in the States where it was produced. Of the total output 27 per cent was shipped to other States by rail and 26 per cent was taken by railroads entering the coal fields or having all-rail connection with the producing districts.

Among the large coal-producing States West Virginia is exceptional as regards coal used within its borders, for in 1915 only 8 per cent of the coal mined in that State was used there, compared with 38 per cent for Pennsylvania, 45 per cent for Illinois, and 43 per cent for Ohio.

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Distribution of bituminous coal produced in the United States, 1915, by routes and destination.

Source.	All-rail shipments.								Shipped to tide-water.		Shipped to Great Lakes for cargo.		Total quantity (net tons).
	Used within the State.		Shipped to other States.		Used by railroads.		Exported by rail.						
	Quantity (net tons).	Per-centage of pro-duction.	Quantity (net tons).	Per-centage of pro-duction.	Quantity (net tons).	Per-centage of pro-duction.	Quantity (net tons).	Per-centage of pro-duction.	Quantity (net tons).	Per-centage of pro-duction.	Quantity (net tons).	Per-centage of pro-duction.	
Alabama	7,347,886	49	2,003,717	14	5,072,435	34	.....	.....	503,899	3	.....	.....	14,927,937
Alaska	1,400	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,400
Arkansas	238,386	14	610,425	37	803,295	49	.....	.....	.....	.....	.....	.....	1,652,106
California, Idaho, and Nevada	12,503	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	12,503
Colorado	4,987,475	58	1,248,990	14	2,388,515	28	(a)	.....	.....	.....	.....	.....	8,624,980
Georgia	120,772	90	8,724	6	5,000	4	.....	.....	.....	.....	.....	.....	134,496
Illinois	26,781,713	45	13,119,841	22	18,928,022	33	.....	.....	.....	.....	.....	.....	58,829,576
Indiana	6,394,019	38	4,423,583	26	6,188,550	36	.....	.....	.....	.....	.....	.....	17,006,152
Iowa	2,786,570	37	411,741	5	4,415,832	58	.....	.....	.....	.....	.....	.....	7,614,143
Kansas	1,879,725	28	1,790,248	26	3,154,501	46	.....	.....	.....	.....	.....	.....	6,824,474
Kentucky	4,429,055	21	11,580,796	54	4,649,823	22	.....	.....	.....	.....	702,000	3	21,361,674
Maryland	852,169	20	1,892,027	45	387,121	10	(a)	.....	1,049,160	25	.....	.....	4,180,477
Michigan	761,217	66	.....	.....	394,921	34	(a)	.....	.....	.....	.....	.....	1,156,138
Missouri	1,059,416	28	400,237	10	2,351,940	62	.....	.....	.....	.....	.....	.....	3,811,593
Montana	1,638,750	59	100,686	3	1,050,319	38	.....	.....	.....	.....	.....	.....	2,789,755
New Mexico	1,056,438	28	777,437	20	1,635,752	43	155,030	4	193,283	5	.....	.....	3,817,940
North Dakota	519,969	98	5,000	1	3,109	1	.....	.....	.....	.....	.....	.....	528,078
Ohio	9,663,496	43	2,317,036	10	7,895,733	35	60,811	.9	15,000	.01	[b]2,482,615	11	22,434,691
Oklahoma	722,555	20	397,275	11	2,573,750	69	.....	.....	.....	.....	.....	.....	3,693,580
Oregon	32,315	82	.....	.....	5,000	13	.....	.....	1,916	5	.....	.....	39,231
Pennsylvania	59,993,642	38	40,220,496	26	30,294,892	19	3,866,406	2	13,960,000	9	[c]9,619,701	6	157,955,137
South Dakota	10,593	100	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,593
Tennessee	1,340,737	23	1,014,163	18	3,375,461	59	.....	.....	.....	.....	.....	.....	5,730,361
Texas	873,456	42	.....	.....	1,037,249	50	78,203	3	100,000	5	.....	.....	2,088,908
Utah	1,903,749	61	639,477	21	565,489	18	.....	.....	.....	.....	.....	.....	3,108,715
Virginia	2,004,344	25	2,824,961	35	2,526,716	31	.....	.....	[d]766,575	9	.....	.....	8,122,596
Washington	932,488	39	197,090	8	1,149,446	47	.....	.....	150,071	6	.....	.....	2,429,095
West Virginia	6,000,117	8	32,555,406	42	9,478,401	12	42,913	.....	[e]20,405,060	27	[f]8,702,172	11	77,184,069
Wyoming	609,546	9	1,721,011	26	4,223,290	65	181	.....	.....	.....	.....	.....	6,554,028
	[g]144,954,501	33	[h]120,260,367	27	[i]114,554,562	26	[j]4,203,544	1	37,144,964	8	21,506,488	5	442,624,426

[a] Included in shipments to other States.
[b] Includes 310,395 tons used by railroads in the Great Lakes region.
[c] Includes 3,435,693 tons used by railroads in the Great Lakes region.
[d] Includes 300,000 tons used by railroads in New England.
[e] Includes 1,776,419 tons used by railroads in New England.
[f] Includes 800,134 tons used by railroads in the Great Lakes region.
[g] Includes coal used at mines for steam and heat, and that sold to local trades and used by employees, and made into coke at the mines, none of which is shipped.
[h] Includes 100,397 tons from Colorado, Kentucky, and Maryland, exported by rail.
[i] All-rail delivery only (see table on pages 474–475 for complete figures).
[j] Does not include 100,397 tons from Colorado, Kentucky, and Maryland exported by rail and included under shipments to other States. Total exports by rail were 4,303,941 net tons.

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DISTRIBUTION OF TIDEWATER SHIPMENTS.

The tidewater shipments of bituminous coal in the United States in 1915 were about 37,100,000 net tons. This quantity includes coal dumped at tidewater points on the Atlantic, Pacific, and Gulf coasts (including that floated down Mississippi River) and shipped to foreign countries, shipped coastwise for points in the United States, and used for bunker fuel for steamers in both foreign and domestic trade. It does not include the coal dumped at New York and used in the city (see p. 501), but it does include coal dumped at Baltimore and Philadelphia and used either on Chesapeake Bay "inside the capes," or on Delaware Bay, or on Delaware River.

The statistics showing the quantity of bituminous coal shipped to tidewater and its origin were collected without great difficulty, but the collection of statistics showing the disposition of this coal has presented one of the most complicated problems connected with the preparation of this report. The figures of the Bureau of Foreign and Domestic Commerce have been accepted for foreign exports and foreign bunker, and an acceptable figure has been obtained for the quantity of bituminous coal used for bunker fuel in the domestic trade (see p. 475). The remainder was coastwise movement for consumption on land. A part of the coastwise cargo coal is ultimately used for bunkering vessels, and the quantity so used appears in the statements of bunker coal as well as in the statistics of coastwise movement.

The origin of the coal shipped to tidewater is shown in the table on page 439. Ten States contributed to the total, of which more than 34,300,000 tons, or 92 per cent, was from Pennsylvania and West Virginia. The tidewater shipments in 1915 from West Virginia were 20,400,000 net tons, or 27 per cent of the production in that State. These shipments reached the seaboard at all the important coal ports on the Atlantic—Hampton Roads, Baltimore, Philadelphia, and New York. The tidewater shipments from Pennsylvania were 13,960,000 net tons, or 9 per cent of the production of bituminous coal in that State in 1915. These shipments were dumped into vessels at Baltimore, Philadelphia, and New York. Coal from Maryland reaches tidewater at Washington, D. C., by way of the Chesapeake & Ohio Canal, at Baltimore, at Philadelphia, and to a small extent at New York.

Tidewater deliveries at points on the Gulf of Mexico are received from Alabama, Texas, and New Mexico. Coal from Alabama also reaches tidewater at ports in South Carolina and Georgia, as does some coal from Virginia. The greater part of the tidewater shipments from Virginia, however, are dumped at Hampton Roads. The unusual condition in coal transportation in 1915, caused by shortages of coal cars in the Eastern States, permitted a small quantity of coal from Ohio (15,000 net tons) to reach the Atlantic seaboard, although under normal conditions no coal from that State is moved to tidewater.

The coal that reaches tidewater on the Pacific coast is shipped from mines in Washington and Oregon. In 1915 150,071 net tons were shipped to Puget Sound from Washington coal fields and 1,916 net tons to Coos Bay, Oreg., from the near-by coal field. Some coal from

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Wyoming, Utah, or New Mexico is doubtless used at San Francisco and Los Angeles for bunker fuel, but no statistics to show that fact are available.

The coal shipped to tidewater is used for bunkering steamships, is exported to foreign countries, or is shipped coastwise and used on land at points in the United States other than those at which it was loaded on vessels, or is loaded on other vessels for bunker fuel. In other words, the statistics of the total coastwise shipments and the total bunker coal, as reported, involve some duplication. The following table shows as nearly as can be ascertained the distribution of the tidewater shipments in 1915. The exports to foreign countries ("offshore" movement) were 9,178,484 net tons, the coastwise shipments for consumption on land were 16,551,480 tons (15,350,000 tons for New England and 1,201,480 tons for other points, mainly on Chesapeake Bay), and the bunker fuel supplied was 11,415,000 tons, a total of 37,144,964 net tons, or 8 per cent of the production in 1915.

Shipments of coal to tidewater in 1915.

	Net tons.
Foreign export	9,178,484
Coastwise shipments:	
For consumption in New England	[1] 15,350,000
For consumption at other United States ports	1,201,480
Total coastwise shipments for consumption on land	16,551,480
For bunker fuel	2,148,520
Total coastwise shipments	18,700,000
Bunker coal (foreign and domestic trade):	
Loaded at New York, Philadelphia, Baltimore, Hampton Roads, and New Orleans	8,882,000
Loaded at Porto Rico, Hawaii, Alaska, and San Francisco	255,000
Loaded at all other ports	2,278,000
Total bunker coal	11,415,000
Total tidewater shipments	[2] 37,144,964

DISTRIBUTION OF LAKE CARGO SHIPMENTS.

The statistics presented in the following table, covering the distribution of bituminous coal from the docks at the head of the Lakes in 1915, are based on detailed reports from the six largest companies with docks on Lake Michigan and Lake Superior, reports from all the important railroads that reach the upper Lakes, reports of Army engineers, and the report of the Milwaukee Chamber of Commerce, supplemented by estimates received from reliable sources. No figures by which these statistics may be checked are available, and it is, therefore, not possible to test their accuracy, but it is believed that they represent very closely the business done in the Great Lakes region.

According to these statistics nearly 22,000,000 tons of bituminous coal were received at the upper Lake ports of the United States and

[1] Includes 2,076,419 tons used by railroads.
[2] In this total the bunker coal included in coastwise shipments (2,148,520 tons) is counted only once, though it is also included in the total bunker coal (11,415,000 tons).

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Canada in 1915. The coal received at Canadian ports and shipped by rail to Canada from American ports amounted to about 5,300,000 net tons, or 24 per cent of the total Lake coal. The railroads used 4,500,000 tons, or 21 per cent of the total, and 12,100,000 tons was shipped to interior points or used at the city or port where it was received. Wisconsin used about 4,900,000 tons, Minnesota about 3,800,000 tons. The receipts at Chicago and adjacent points in Indiana at the lower end of Lake Michigan were more than 1,500,000 tons.

The quantity distributed appears to have been about 500,000 tons greater than the receipts.

Distribution of Lake cargo bituminous coal, 1915.

	Quantity (net tons).	Percentage of total.
Shipped to States by rail from docks on Lake Superior and Lake Michigan:		
Idaho	1,000	
Illinois	1,084,000	
Indiana	551,000	
Iowa	248,000	
Michigan	558,000	
Minnesota	3,793,000	
Montana	3,000	
Nebraska	100,000	
North Dakota	553,000	
Oregon	500	
South Dakota	357,000	
Washington	100	
Wisconsin	4,883,000	
	12,131,600	55
Used by railroads in the Northwest	4,546,222	21
Exported to Canada by water and rail	5,291,357	24
Total distributed from upper Lake ports	21,969,179	100
Shipments of lake cargo from lower Lake ports	21,506,488	
Shipments from upper Lake docks in excess of receipts	462,691	

BITUMINOUS COAL AND LIGNITE SHIPPED BY RAILROADS AND RIVERS.

According to the reports furnished to the Geological Survey by the coal operators, bituminous coal and lignite shipped by railroads in 1915 amounted to 370,336,585 net tons, compared with 355,855,510 tons in 1914. The shipments, which are summarized by railroads in the accompanying table, include all coal loaded on cars at the mines. A small part of the coal shipped is carried but a short distance, perhaps only switched from the tipple to coke ovens or to some near-by industrial plant, but the greater part is moved a considerable distance from the mines. As these statistics include fuel coal taken by railroads that serve the coal mines, not all the shipments furnished revenue to the railroads, coal for "company use" being nonrevenue freight. The statistics of coal traffic published by a railroad company usually show only revenue freight and include coal received from connecting lines as well as that originating at mines on the line. For that reason the figures given in the following table will be at variance with those that may be compiled by the railroads.

The table of railroad shipments in this report is arranged in a form different from that of the tables in previous reports of the

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series. The quantities of bituminous coal and lignite shipped on each road are given in so far as they can be published without disclosing the output of individual mines, rather than combined, as in previous reports, according to the railroad system to which the roads belong, and the names of the roads are arranged in alphabetic order rather than in the order of the importance of the roads as coal carriers. The name of every railroad on which coal was reported to have originated is given, with (for most of the roads) the quantity from each State. Roads on which the mines are operated by less than three companies are grouped at the end of the table in such manner as not to disclose the operation of mines or companies.

Shipments originating on rivers are given at the end of the table.

Shipments of bituminous coal in the United States, by railroads and waterways, in 1915.

Route.	State.	Quantity.	Total.
Railroad.		*Net tons.*	*Net tons.*
Alabama Great Southern	Alabama	51,507	51,507
Arkansas Central	Arkansas	11,101	11,101
Ashland Coal & Iron	Kentucky	91,579	91,579
Atchison, Topeka & Santa Fe (includes New Mexico Midland and Santa Fe, Raton & Eastern)	Colorado	491,322	5,157,375
	Illinois	410,510	
	Kansas	1,589,075	
	Missouri	253,386	
	New Mexico	2,278,378	
	Oklahoma	134,704	
Atlanta, Birmingham & Atlantic	Alabama	180,859	180,859
Baltimore & Ohio (includes Sandy Valley & Elkhorn)	Illinois	1,161,119	32,723,535
	Kentucky and Maryland.	1,376,571	
	Ohio	4,438,401	
	Pennsylvania	10,921,949	
	West Virginia	14,825,495	
Baltimore & Ohio Southwestern	Illinois and Indiana.	504,387	863,717
	Ohio	359,330	
Bessemer & Lake Erie	Pennsylvania	2,638,922	2,638,922
Birmingham Southern	Alabama	2,390,482	2,390,482
Buffalo, Rochester & Pittsburgh	Pennsylvania	6,728,400	6,728,400
Centerville, Albia & Southern	Iowa	7,855	7,855
Central of Georgia	Alabama and Georgia.	788,716	788,716
Chesapeake & Ohio (includes Piney River & Paint Creek)	Kentucky	2,026,570	22,993,769
	West Virginia	20,967,199	
Chicago & Alton	Illinois	2,232,409	2,427,055
	Missouri	194,646	
Chicago & Eastern Illinois	Illinois	4,197,277	8,552,123
	Indiana	4,354,846	
Chicago & Northwestern (includes Wyoming & Northwestern)	Illinois	3,497,417	5,156,843
	Iowa	1,510,090	
	Wyoming	149,336	
Chicago, Burlington & Quincy	Colorado and Wyoming.	1,933,108	11,828,656
	Illinois	8,460,895	
	Iowa	1,100,075	
	Missouri	334,578	
Chicago Great Western	Iowa	497,111	497,111
Chicago, Indianapolis & Louisville	Indiana	971,302	971,302
Chicago, Milwaukee & St. Paul	Illinois	1,438,230	3,688,018
	Iowa	1,382,737	
	Montana, South Dakota, and Washington.	858,852	
	North Dakota	8,199	
Chicago, Peoria & St. Louis	Illinois	570,277	570,277
Chicago, Rock Island & Pacific (includes Chicago, Rock Island & Gulf)	Arkansas	189,738	3,366,347
	Colorado, Missouri, and Texas.	165,864	
	Illinois	159,319	
	Iowa	1,778,033	
	Oklahoma	1,073,393	
Chicago, Terre Haute & Southeastern	Indiana	3,363,549	3,363,549
Cincinnati, Hamilton & Dayton	Illinois	187,659	418,116
	Ohio	230,457	
Cincinnati, New Orleans & Texas Pacific	Kentucky	86,526	383,209
	Tennessee	296,683	

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Shipments of bituminous coal in the United States, by railroads and waterways, in 1915—Continued.

Route.	State.	Quantity.	Total.
Railroad—Continued.		*Net tons.*	*Net tons.*
Cleveland, Cincinnati, Chicago & St. Louis	Illinois	6,962,652	8,052,936
	Indiana	1,090,284	
Coal & Coke	West Virginia	858,461	858,461
Colorado & Southern	Colorado	1,884,512	1,884,512
Colorado Midland	do	237,431	237,431
Cumberland	Kentucky	310,972	310,972
Cumberland & Georges Creek	Maryland	337,629	337,629
Cumberland & Pennsylvania	do	2,908,404	2,908,404
Denver & Rio Grande (includes Ballard & Thompson, Kenilworth & Helper, and Rio Grande Southern)	Colorado and New Mexico.	1,967,983	4,239,784
	Utah	2,271,801	
Denver & Salt Lake	Colorado	823,560	823,560
Detroit, Toledo & Ironton	Ohio	233,552	233,552
Elgin, Joliet & Eastern	Illinois	304,510	304,510
Erie	Ohio	106,695	1,900,142
	Pennsylvania	1,793,447	
Evansville, Suburban & Newburgh	Indiana	99,425	99,425
Fort Dodge, Des Moines & Southern	Iowa	63,052	63,052
Frisco (includes Alabama Central, Birmingham Belt, and B. R. L. & P. (Huntingdon)	Alabama	1,793,672	5,397,975
	Arkansas	467,913	
	Kansas	2,364,463	
	Missouri	266,764	
	Oklahoma	505,163	
Great Northern	Montana	648,831	700,820
	North Dakota and Washington.	51,989	
Harriman & Northeastern	Tennessee	278,428	278,428
Hocking Valley	Ohio	2,764,987	2,764,987
Huntingdon & Broad Top Mountain	Pennsylvania	792,218	792,218
Illinois Central	Alabama	95,553	13,925,913
	Illinois	10,006,171	
	Indiana	242,704	
	Kentucky	3,581,485	
Illinois Southern	Illinois	220,632	220,632
Illinois Traction System	do	350,772	350,772
Indian Creek Valley	Pennsylvania	13,644	13,644
International & Great Northern	Texas	316,855	316,855
Iowa & St. Louis	Iowa and Missouri.	67,015	67,015
Kanawha & Michigan	Ohio	550,627	3,450,241
	West Virginia	2,899,614	
Kansas City Southern (includes Arkansas Western)	Arkansas & Oklahoma.	139,168	844,063
	Kansas	574,184	
	Missouri	130,711	
Kentucky & Tennessee	Kentucky	480,241	480,241
Lake Erie, Franklin & Clarion	Pennsylvania	388,858	388,858
Ligonier Valley	do	829,067	829,067
Litchfield & Madison	Illinois	883,911	883,911
Louisville & Nashville (includes Warrior Mineral)	Alabama	3,229,139	13,569,642
	Illinois and Indiana.	389,900	
	Kentucky	8,376,753	
	Tennessee	1,362,554	
	Virginia	211,296	
Louisville, Henderson & St. Louis	Kentucky	86,001	86,001
Marietta, Columbus & Cleveland	Ohio	117,616	117,616
Michigan Central	Michigan	514,262	514,262
Midland Valley	Arkansas	234,848	294,106
	Oklahoma	59,258	
Minneapolis & St. Louis	Illinois	629,237	1,045,681
	Iowa	416,444	
Minneapolis, St. Paul & Sault Ste. Marie	Montana and North Dakota.	162,683	162,683
Missouri, Kansas & Texas (includes Wichita Falls & Southern)	Kansas	851,868	2,382,263
	Missouri	77,888	
	Oklahoma	1,059,996	
	Texas	392,511	
Missouri, Oklahoma & Gulf	Oklahoma	402,515	402,515
Missouri Pacific	Arkansas	52,309	2,219,987
	Kansas	1,110,605	
	Missouri	1,057,073	
Mobile & Ohio	Alabama	309,162	1,058,192
	Illinois	749,030	
Monongahela	Pennsylvania	458,425	547,856
	West Virginia	89,431	
Montana, Wyoming & Southern	Montana	421,891	421,891
Montour	Pennsylvania	2,684,010	2,684,010
Nashville, Chattanooga & St. Louis	Alabama and Tennessee.	1,068,870	1,068,870
New York Central (includes Lake Shore & Michigan Southern and New York Central & Hudson River)	Ohio	1,396,557	9,734,495
	Pennsylvania	8,337,938	

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***Shipments of bituminous coal in the United States, by railroads and waterways, in 1915*—Continued.**

Route.	State.	Quantity.	Total.
Railroad—Continued.		*Net tons.*	*Net tons.*
Norfolk & Western	Kentucky	2,115,304	26,839,534
	Virginia	2,633,874	
	West Virginia	22,090,356	
Northern Pacific	Montana	646,335	2,219,186
	North Dakota	140,014	
	Washington	1,432,837	
Pennsylvania (includes Pittsburgh, Cincinnati, Chicago & St. Louis).	Maryland	30,661	64,093,980
	Ohio	6,024,037	
	Pennsylvania	57,059,578	
	West Virginia	979,704	
Peoria & Pekin Union	Illinois	323,498	323,498
Peoria Railway Terminal Co	do	323,080	323,080
Pere Marquette (includes Detroit, Bay City & Western)	Michigan	563,683	563,683
Pittsburgh & Lake Erie	Pennsylvania	7,112,110	7,112,110
Pittsburgh & Susquehanna	do	190,179	190,179
Pittsburgh, Chartiers & Youghiogheny	do	793,273	793,273
Pittsburgh, Lisbon & Western	Ohio and Pennsylvania.	68,373	68,373
Pittsburgh, Shawmut & Northern	Pennsylvania	2,666,986	2,666,986
Quincy, Omaha & Kansas City	Missouri	143,592	143,592
St. Louis, Iron Mountain & Southern (includes Dardanelle & Russellville).	Arkansas	580,962	3,425,647
	Illinois	2,844,685	
St. Louis Southwestern Railway of Texas	Texas	59,884	59,884
Southern (includes Northern Alabama)	Alabama	2,895,131	6,943,086
	Illinois and Indiana.	1,605,972	
	Kentucky	581,482	
	Tennessee	1,860,501	
Southern Pacific (includes Coos Bay, Roseburg & Eastern, Galveston, Harrisburg & San Antonio, and Houston & Texas Central).	California and Oregon.	29,711	140,070
	Texas	110,359	
Tennessee Central	Tennessee	337,471	337,471
Toledo & Ohio Central	Ohio	945,820	945,820
Toledo, Peoria & Western	Illinois	154,305	154,305
Toledo, St. Louis & Western	Illinois and Indiana.	619,723	619,723
Union Pacific System (includes Colorado, Wyoming & Eastern, Oregon Short Line, and Oregon-Washington R. R. & Navigation Co.).	Colorado	387,381	5,116,978
	Kansas	45,677	
	Missouri and Utah	75,311	
	Washington	110,264	
	Wyoming	4,498,345	
Vandalia	Illinois	820,239	5,518,162
	Indiana	4,697,923	
Virginia & Kentucky	Virginia	38,457	38,457
Virginia & Southwestern	Kentucky and Virginia.	1,956,045	1,956,045
Virginian	Virginia and West Virginia.	4,002,365	4,002,365
Wabash	Illinois	2,376,508	2,667,683
	Iowa and Missouri.	291,175	
Wabash, Chester & Western	Illinois	36,909	36,909
Wabash Pittsburgh Terminal	Ohio and West Virginia.	116,664	699,137
	Pennsylvania	582,473	
Western Allegheny	do	376,628	376,628
Western Maryland	Maryland	690,872	3,690,249
	Pennsylvania	88,052	
	West Virginia	2,911,325	
West Virginia Northern	do	169,850	169,850
Wheeling & Lake Erie	Ohio	1,751,918	1,751,918
Zanesville & Western	do	595,264	595,264
Miscellaneous:			
Seaboard Air Line	Alabama	380,255	380,255
Thomas & Sayreton			
Colorado & Southeastern	Colorado	858,413	858,413
Colorado & Wyoming			
Denver & Intermountain			
Trinidad Electric			
Chicago & Illinois Midland	Illinois	1,301,436	1,301,436
Chicago, Indiana & Southern			
East St. Louis & Suburban			
St. Louis & Belleville Electric	do	1,930,312	1,930,312
St. Louis & O'Fallon			
St. Louis, Troy & Eastern			
Lake Erie & Western	do	270,320	270,320
Rock Island Southern			
Unspecified	do	4,320	4,320
Central Indiana	Indiana	65,327	65,327
Evansville Belt			
Unspecified			

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Shipments of bituminous coal in the United States, by railroads and waterways, in 1915—Continued.

Route.	State.	Quantity.	Total.
Railroad—Continued.			
Miscellaneous—Continued.			
Colfax Northern Interurban Eastern Kentucky Kentucky Midland K. R. & C. Morehead & North Fork Ohio & Kentucky Bevier & Southern Kansas City, Clinton & Springfield St. Louis & Hannibal El Paso & Southwestern New Mexico Central Lake Erie, Alliance & Wheeling Ohio River & Western Youngstown & Ohio River Youngstown & Southern Electric Fort Smith & Western Fort Smith, Poteau & Western Altoona Northern Cambria & Indiana Johnstown & Stony Creek Kittanning Run Buffalo & Susquehanna R. R. Corp. Indiana County Street Railways Reynoldsville & Falls Creek Rural Valley Central Pennsylvania Lumber Co. Tramroad Susquehanna & New York East Broad Top R. R. & Coal Co. Juniata & Southern Eastern Ohio Tramway Union West Side Belt New Haven & Dunbar United Railway Washington Run Rio Grande & Eagle Pass San Antonio & Aransas Pass Texas & Pacific Texas Short Line Trinity & Brazos Valley Carolina, Clinchfield & Ohio Interstate Unspecified Centralia Eastern Columbia & Puget Sound Puget Sound & Willapa Harbor Puget Sound Electric Tacoma Eastern Buffalo Creek & Gauley Morgantown & Kingwood Preston West Virginia Midland Campbells Creek Kanawha & West Virginia Kanawha Central Cherry River Boom & Lumber Co. Kanawha, Glen Jean & Eastern	Iowa Kentucky Missouri New Mexico Ohio Oklahoma Pennsylvania do do do do Texas Virginia Washington West Virginia do do	136,595 138,030 445,793 737,644 364,330 39,136 1,222,747 2,429,944 17,131 602,058 2,299,132 394,439 1,093,813 2,191,087 530,811 1,100,354 665,390 414,260	136,595 138,030 445,793 737,644 364,330 39,136 1,222,747 2,429,944 17,131 602,058 2,299,132 394,439 1,093,813 2,191,087 530,811 1,100,354 665,390 414,260
Total railroad shipments		370,336,585	370,336,585
Waterway.			
Kanawha River	West Virginia	877,668	877,668
Monongahela River	Pennsylvania and West Virginia.	7,726,998	7,726,998
Ohio River	Indiana and West Virginia. Kentucky Ohio	41,597 595,629 103,862	741,088
Warrior River	Alabama	169,618	169,618
Miscellaneous: Coquille River Green River Illinois River	Oregon Kentucky Illinois	24,634	24,634
Total waterway shipments		9,540,006	9,540,006
Grand total		379,876,591	379,876,591

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DISTRIBUTION BY STATES.

ALABAMA.

In its output of coal Alabama is the most productive State in the South, and it is centrally located as regards the markets of the Southern States. In 1915 the southern railroads used nearly 5,000,000 tons of Alabama coal, which is 32 per cent of the production in Alabama and nearly 23 per cent of the consumption by the railroads in the South. About 200,000 tons of coal from Alabama was used by railroads west of Mississippi River. In addition to that taken by the railroads, more than 7,300,000 tons, or nearly half the total output, was used in the State; 2,000,000 tons, or 13.5 per cent of the output, was shipped to other States; and 500,000 tons, or 3.5 per cent, went to tidewater for foreign and domestic cargo and bunker fuel. Of the coal shipped outside the State for commercial use the greater part, about 1,500,000 tons, reached the Mississippi Valley markets in Louisiana and Mississippi and in a less amount those in Missouri, Tennessee, and Arkansas. On the east, Georgia and Florida are the best consumers of Alabama coal.

Competition by coal from the fields to the north, particularly those of southern Illinois and western Kentucky, restricts the expansion of markets for coal from Alabama in the Mississippi Valley and at New Orleans. Similar competition on the east by coal from Virginia, Kentucky, and Tennessee meets coal from Alabama in the markets of the Carolinas and Georgia. The higher grades of Alabama coal are sent in small shipments to markets as distant as the Pacific coast. The tidewater business at southern Atlantic ports (except Hampton Roads) and at gulf ports is not very large as compared with that at the northern ports, and in 1915 it was below normal. About 500,000 tons of coal from Alabama reached tidewater in 1915.

Coal shipped to tidewater points from Alabama in 1915, in net tons.

Port.	Quantity.	Use.	Quantity.
Mobile, Ala.	103,320	Foreign export	23,641
Pensacola, Fla.	145,369	Foreign bunker	319,307
New Orleans, La.	116,205	Domestic bunker	160,951
South Carolina ports	11,904		
Georgia ports	127,101		
	503,899		503,899

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Distribution of coal mined in Alabama in 1915.

	Quantity (net tons)	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Alabama			Shipped to other States—Continued.		
Used at mines for steam and heat	535,340		Oklahoma	713	
Sold to local trade, not shipped	289,239		Oregon	190	
Made into coke at mines	1,780,872		Tennessee	161,754	
Shipped to Alabama points	4,742,435		Texas	39,987	
			Virginia	307	
			Washington	21	
Total used in Alabama	7,347,886	49	Total shipped to other States (all rail)	2,003,717	14
Shipped to other States:			Shipped to tidewater	503,899	3
Arkansas	10,450		Used by railroads:		
California	292		Loaded at mine tipples	100,000	
Florida	108,782		Shipped	4,972,435	
Georgia	363,572				
Louisiana	717,437		Total used by railroads	5,072,435	34
Mississippi	596,218				
Missouri	3,519				
North Carolina and South Carolina	475		Total production	14,927,937	100

ARKANSAS.

Of the total coal mined in Arkansas in 1915 nearly half (800,000 net tons) was used as fuel by railroads. Of the remainder about 240,000 tons was consumed in Arkansas and approximately 610,000 tons was distributed in near-by States for commercial and domestic uses. The greater part of the coal (other than railroad fuel) that is shipped from Arkansas reaches markets to the north and west, in Missouri, Kansas, and Nebraska. The better grades of Arkansas coal, which are semianthracite, find a small market in the neighboring States of Oklahoma, Texas, and Louisiana, west of the Mississippi, and in Tennessee, east of the Mississippi, and some Arkansas coal is shipped to Iowa and Minnesota.

Distribution of coal produced in Arkansas in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Arkansas:			Shipped to other States—Continued.		
Used at mines for steam and heat	62,175		Minnesota	5,372	
Sold to local trade, not shipped	46,260		Missouri	198,768	
Shipped to points in Arkansas	129,951		Nebraska	120,376	
			Oklahoma	60,791	
			Tennessee	15,258	
			Texas	78,418	
Total used in Arkansas	238,386	14	Total shipped to other States (all rail)	610,425	37
Shipped to other States:					
Iowa	16,537		Used by railroads	803,295	49
Kansas	114,812				
Louisiana	93		Total production	1,652,106	100

COLORADO.

In view of the relative excellence of the coal mined in Colorado and the advantageous location of the more productive developed fields on the east front of the Rocky Mountains, it is surprising that so little Colorado coal finds markets in the region east of the State. In 1915 only 1,250,000 tons, or 14 per cent of the output, was shipped

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to other States, Kansas, Nebraska, Oklahoma, and Texas taking the greater part of this quantity. The coal consumed within the State in 1915, including that used for operating the coal mines and for making coke, amounted to nearly 5,000,000 tons, or 58 per cent of the production, and railroads used nearly 2,400,000 tons, or 28 per cent.

Distribution of coal produced in Colorado in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Colorado:			Shipped to other States—Continued.		
Used at mines for steam and heat	294,571		Nebraska	422,320	
Sold to local trade, not shipped	291,243		Nevada and Utah	2,526	
Made into coke at mines	1,015,346		New Mexico	22,948	
Shipped to Colorado points	3,386,315		Oklahoma	120,298	
			South Dakota	12,598	
			Texas	[a] 273,337	
			Wyoming	20,984	
Total used in Colorado	4,987,475	58	Total shipped to other States and exported	1,248,990	14
Shipped to other States:					
Arkansas	14,234		Used by railroads	2,388,515	28
California	5,771				
Iowa	12,660		Total production	8,624,980	100
Kansas	340,779				
Missouri	535				

[a] Includes coal exported to Mexico.

ILLINOIS.

The coal fields of Illinois, the third State in rank in the production of coal, are favorably situated in respect to the markets of the middle western territory. Coal was shipped from mines in Illinois to 17 other States, from Ohio on the east to the Dakotas and Nebraska on the west, and from Canada on the north to the Gulf of Mexico on the south. The extent of the sales of coal from Illinois in these States is, of course, determined by the competition offered by coal from other States. Because of the competition of higher-grade coal from the Appalachian fields, little coal from Illinois moves east of Chicago; that shipped to Indiana in 1915, as shown by the accompanying table, was used largely in the district about Chicago, and that reported as shipped to Michigan was probably used in the Upper Peninsula. The coal shipped in 1915 from Illinois to Mississippi, Louisiana, and Texas was about 185,000 tons. The main sources of coal supply in these States are those coal fields of Alabama, Kentucky, and Arkansas that are nearer than the Illinois fields.

It is on the west and northwest that the coal from Illinois finds its largest market. In 1915 Missouri and Iowa consumed more than 7,400,000 tons of Illinois coal, and Kansas and Nebraska, where competition with coal from the Rocky Mountain fields is met, used about 1,350,000 tons of Illinois coal. In Wisconsin, Minnesota, and the Dakotas, 3,000,000 tons of coal from Illinois were used in 1915. It is in this territory that coal from fields to the south, arriving by all-rail routes, meets in competition the coal from Pennsylvania, Ohio, West Virginia, and Kentucky that reaches the head of the Lakes or the lower end of Lake Michigan by water from ports on Lake Erie.

The coal that was both mined and burned in Illinois in 1915 amounted to 26,780,000 tons, or 45 per cent of the output of the State. About 4,000,000 tons of this quantity was used at or near the mines

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and the remainder, 22,780,000 tons, was shipped to points in Illinois. Chicago, which is, of course, the largest coal-consuming center in Illinois, burned about 10,000,000 tons of Illinois coal in 1915. The districts about Peoria and in and around East St. Louis are also large consumers of coal and, with other places, used about 12,000,000 tons of Illinois coal in 1915.

The railroads used nearly 19,000,000 tons, or 33 per cent of the total production, so that in Illinois, as in many other States, the condition of the coal industry depends in no small measure on the prosperity of the common carriers.

Distribution of coal produced in Illinois in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Illinois:			Shipped to other States—Continued.		
Used at mines for steam and heat	1,533,069		Mississippi	96,577	
Sold to local trade, not shipped	2,470,114		Missouri	4,391,722	
Shipped to Illinois points	22,778,530		Nebraska	938,905	
Total used in Illinois	26,781,713	45	North Dakota	106,674	
Shipped to other States:			Ohio	3,036	
Arkansas	128,950		South Dakota	319,370	
Indiana	825,601		Tennessee	68,559	
Iowa	3,053,413		Texas	20,648	
Kansas	414,467		Wisconsin	1,260,188	
Kentucky	6,807		Total shipped to other States (all rail)	13,119,841	22
Louisiana	67,338		Used by railroads	18,928,022	33
Michigan	83,256		Total production	58,829,576	100
Minnesota	1,334,330				

INDIANA.

The three great markets for the coal mined in Indiana are Indiana, Illinois, and the railroads that use it as fuel. In 1915, 38 per cent of the output was consumed within the State, 26 per cent was shipped to others States—nearly all of it to Illinois—and 36 per cent was used by railroads. About 3,000,000 tons of the 4,000,000 tons of Indiana coal consumed in Illinois was used in the Chicago district. Iowa, Wisconsin, and Minnesota received the greater part of the remainder of the coal shipped from Indiana to other States.

Distribution of coal produced in Indiana in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Indiana:			Shipped to other States—Continued.		
Used at mines for steam and heat	425,352		Missouri	12,632	
Sold to local trade, not shipped	547,761		Nebraska	2,833	
Shipped to Indiana points	5,420,906		North Dakota	3,255	
Total used in Indiana	6,394,019	38	South Dakota	3,897	
Shipped to other States:			Tennessee	33	
Illinois	4,044,528		Wisconsin	128,190	
Iowa	149,046		Total shipped to other States (all rail)	4,423,583	26
Kansas	149		Used by railroads	6,188,550	36
Michigan	6,086		Total production	17,006,152	100
Minnesota	72,934				

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IOWA.

The competition offered by coal from other States, particularly that from Illinois, for the market in Iowa and surrounding territory is so strong that the coal operators in Iowa retain with difficulty their share of the market, even in their own State. Only 5 per cent of the output was shipped from Iowa to other States in 1915. More than 4,400,000 tons, or 58 per cent, was used by railroads and about 2,786,000 tons, or 37 per cent of the production, was consumed within the State.

Distribution of coal produced in Iowa in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Iowa:			Shipped to other States—Continued.		
Used at mines for steam and heat	148,159		Missouri	174,164	
Sold to local trade, not shipped	502,286		Nebraska	143,108	
Shipped to Iowa points	2,136,125		South Dakota	24,120	
Total used in Iowa	2,786,570	37	Total shipped to other States	411,741	5
Shipped to other States:			Used by railroads	4,415,832	58
Illinois	17,700		Total production	7,614,143	100
Kansas	40,092				
Minnesota	12,557				

KANSAS.

In Kansas, as in most other States west of the Mississippi, the railroads are the largest consumers of coal. In 1915 more than 3,150,000 tons of coal, or 46 per cent of the production of the Kansas mines, was sold to railroads. For domestic and industrial uses nearly 1,900,000 tons, or 28 per cent of the output, was consumed in the State, and 1,790,000 tons were shipped to other States, the greater part going to Missouri and Nebraska.

Distribution of coal produced in Kansas in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Kansas:			Shipped to other States—Continued.		
Used at mines for steam and heat	184,071		Nebraska	774,937	
Sold to local trade, not shipped	104,531		Oklahoma	75,162	
Shipped to Kansas points	1,591,123		Total shipped to other States (all rail)	1,790,248	26
Total used in Kansas	1,879,725	28	Used by railroads	3,154,501	46
Shipped to other States:			Total production	6,824,474	100
Arkansas	13,669				
Missouri	926,480				

KENTUCKY.

The remarkable advance that has been made in recent years in the production of coal in Kentucky makes interesting a citation of the markets that have been created for the product. There are in reality two separate coal fields in the State. The field in eastern Kentucky is a part of the Appalachian coal region and is properly considered

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with the fields of West Virginia, Pennsylvania, and Tennessee. The field in western Kentucky is a part of the general interior coal region, which includes the fields in Illinois and Indiana. The two fields differ in kind and quality of coal, in mining conditions, and in accessibility to markets and the distribution of the product from the two should be treated separately; but the data available are not of a kind to permit such a distinction.

The best developed markets for the coal from western Kentucky are to the south and southwest, particularly in the Mississippi Valley; the markets for the coal from eastern Kentucky are mainly to the north and northwest. The production of coal in Kentucky in 1915 was 21,361,674 net tons, of which 65 per cent was from the eastern district and 35 per cent from the western district.

Including the coal used at the mines for steam and heat and that made into coke at the mines, about 21 per cent of the total production of the Kentucky mines in 1915, or 4,429,000 tons, was used in the State. About 4,650,000 tons, or 22 per cent of the output, was consumed by railroads, and about 702,000 tons, or 3 per cent of the production, was shipped to the Great Lakes for transshipment by vessel to the northwest.

More than half the production, 11,580,000 tons, was shipped by rail to other States. The rail shipments were made to 25 States, of which Michigan, Ohio, and Indiana received more than 5,300,000 tons. The all-rail shipments to markets in 1915, other than for railroad fuel, in States north of the Ohio and the Potomac and east of the Mississippi were almost 6,631,000 tons; the shipments to States south of the Ohio and east of the Mississippi, other than Kentucky, were about 3,427,000 tons; and the shipments to markets in States west of the Mississippi were more than 1,522,000 tons.

Distribution of coal produced in Kentucky in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Kentucky:			Shipped to other States—Continued.		
Used at mines for steam and heat	495,313		North Dakota	418	
Sold to local trade, not shipped	586,864		Ohio	1,359,813	
Made into coke at mines	458,105		Pennsylvania	[a] 79,125	
Shipped to Kentucky points	2,888,773		South Dakota	89,220	
Total used in Kentucky	4,429,055	21	Tennessee	1,560,776	
Shipped to other States:			Texas	40,112	
Alabama	86,966		Virginia	2,064	
Arkansas	56,913		West Virginia	87	
Florida	17,268		Wisconsin	379,644	
Georgia	800,822		Total shipped to other States	11,580,796	54
Illinois	864,047		Shipped to Great Lakes for cargo	702,000	3
Indiana	2,886,806		Used by railroads	4,649,823	22
Iowa	335,431		Total production	21,361,674	100
Kansas	54,871				
Louisiana	215,007				
Michigan	1,061,640				
Minnesota	345,333				
Mississippi	630,518				
Missouri	478,164				
Nebraska	92,091				
North Carolina and South Carolina	143,660				

[a] Includes Kentucky coal exported by rail to Canada.

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MARYLAND.

The coal from the fields of Maryland is all of high rank, and what is termed the Georges Creek coal is widely known as one of the best blacksmithing coals mined in the country. Shipments by rail, other than for railroad fuel, were made to 17 States and to New England and amounted to nearly 1,900,000 tons, or 45 per cent of the output.

The largest shipments were made to New England (600,000 tons), New York (567,000 tons), and Pennsylvania (506,000). About 10,000 tons of Maryland coal was used on the Pacific coast in California and Washington, and Maryland coal was used in several States in the Mississippi Valley. More than 1,000,000 tons reached tidewater at Baltimore and New York for foreign export, for use as bunker fuel, and for shipment by water to ports in New England States. Only 387,000 tons, or 10 per cent of the output, was used for railroad fuel in 1915.

Distribution of coal produced in Maryland in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Maryland:			Shipped to other States—Continued.		
Used at mines for steam and heat	64,588		Iowa and Kentucky	5,898	
Sold to local trade, not shipped	38,908		Michigan	48,124	
Shipped to Maryland and District of Columbia points	748,673		Missouri and Texas	9,090	
Total used in Maryland and District of Columbia	852,169	20	Montana	58	
Shipped to other States:			New Jersey	33,561	
California and Washington	10,244		New York	[a] 567,421	
New England	630,097		Ohio	37,305	
Delaware	9,327		Pennsylvania	505,860	
Illinois	20,783		Virginia	787	
Indiana	6,947		West Virginia	6,525	
			Total shipped to other States (all rail)	1,892,027	45
			Shipped to tidewater	1,049,160	25
			Used by railroads	387,121	10
			Total production	4,180,477	100

[a] Includes small quantity exported to Canada by rail.

MISSOURI.

Missouri is surrounded by coal-producing States and therefore only a small part of its output reaches outside markets. In 1915 only 10 per cent of the coal produced in Missouri was shipped to other States, and the greater part of this was consumed in Kansas and Nebraska. Local markets absorbed 28 per cent of the production in 1915 and the railroads used 62 per cent.

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Distribution of coal produced in Missouri in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Missouri:			Shipped to other States—Con.		
Used at mines for steam and heat	84,091		Oklahoma	4,800	
Sold to local trade, not shipped	201,975		Total shipped to other States	400,237	10
Shipped to Missouri points	773,350		Used by railroads:		
			Loaded at mine tipples.	190,000	
Total used in Missouri	1,059,416	28	Shipped	2,161,940	
Shipped to other States:			Total used by railroads	2,351,940	62
Arkansas and Illinois	1,888				
Iowa	22,729		Total production	3,811,593	100
Kansas	167,483				
Nebraska	203,337				

MONTANA.

Most of the coal mined in Montana is consumed within the State. The quantity used in 1915 for domestic and industrial purposes and for operating the coal mines was about 59 per cent of the output; that taken by the railroads, also largely consumed within the State, was 38 per cent of the output. The quantity shipped to other States for domestic use and for making steam was but 3 per cent of the output and reached only four States, North Dakota, South Dakota, Washington, and Idaho.

Distribution of coal produced in Montana in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Montana:			Shipped to other States—Continued.		
Used at mines for steam and heat	122,592		North Dakota	44,814	
Sold to local trade, not shipped	105,924		South Dakota	25,702	
Shipped to Montana points	1,410,234		Washington	20,859	
			Total shipped to other States	100,686	3
Total used in Montana	1,638,750	59			
			Used by railroads	1,050,319	38
Shipped to other States:					
Idaho	9,311		Total production	2,789,755	100

NEW MEXICO.

The coal fields of New Mexico are scattered over the State and offer to the market a variety of fuels, from the subbituminous coal (black lignite) of the Gallup field to the anthracite in Santa Fe County. In 1915 New Mexico shipped coal to eight States, of which Texas and Arizona were the largest customers. The largest single use of New Mexico coal is for railroad fuel, and in 1915 this consumed 43 per cent of the output. More than 1,000,000 tons, or 28 per cent, of the total production was consumed within the State, mainly for making coke, which, in turn, was shipped to other States for consumption. Small quantities of coal mined in New Mexico were exported by rail to Mexico and were shipped to tidewater at points in Texas on the Gulf of Mexico, where it was used as bunker fuel.

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Distribution of coal produced in New Mexico in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in New Mexico:			Shipped to other States—Continued.		
Used at mines for steam and heat	28,868		Kansas	98,103	
Sold to local trade, not shipped	33,277		Nebraska	339	
Made into coke at mines	734,713		Nevada	135	
Shipped to New Mexico points	259,580		Oklahoma	24,096	
			Texas	313,589	
Total used in New Mexico	1,056,438	28	Total shipped to other States	777,437	20
Shipped to other States:			Used by railroads	1,635,752	43
Arizona	158,273		Exported by rail	155,030	4
California	75,025		Shipped to tidewater	193,283	5
Colorado	107,877		Total production	3,817,940	100

NORTH DAKOTA.

In no other State does the home consumption of coal reach a greater proportion to the total output than in North Dakota. This large home use is due in part to the fact that lignite, the only fuel in the State, is not so desirable as bituminous coal and is therefore not used where better fuel can be obtained, and in part to the tendency of this coal to slack on exposure to the air, so that it can not be shipped for long distances. Small quantities of lignite are used by the railroads for heating their stations and 5,000 tons were shipped in 1915 to South Dakota. The remainder, 98 per cent of the production in 1915, was used within the State.

Distribution of coal produced in North Dakota in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in North Dakota:			Shipped to South Dakota	5,000	1
Used at mines for steam and heat	17,499		Used by railroads	[a] 3,109	1
Sold to local trade, not shipped	151,957		Total production	528,078	100
Shipped to North Dakota points	350,513				
Total used in North Dakota	519,969	98			

[a] For station use.

OHIO.

Ohio uses large quantities of coal and in 1915 ranked fourth in the production of coal. Between 9,000,000 and 10,000,000 tons, or about 43 per cent of the coal produced in Ohio in 1915, was used in the State, so it is evident that the local markets are the most favorable for Ohio coal producers. The railroads used about 7,900,000 tons, or 35 per cent of the output in 1915, and 75,000 tons, or 1 per cent, was shipped to tidewater or exported to Canada by rail. The coal shipped from mines in Ohio to other States in 1915 for use otherwise

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than as railroad fuel amounted to 2,317,036 tons, or 10 per cent of the output in 1915. More than half this quantity went to Michigan and the greater part of the remainder to Illinois and Indiana. Little coal goes from Ohio to market by all-rail routes, except to these three States. Ohio is one of the four States that ship coal to market northwestward by the Great Lakes. The Lake shipments from this State in 1915 were 2,482,615 tons, or 11 per cent of the output.

Distribution of coal produced in Ohio in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Ohio:			Shipped to other States—Con.		
Used at mines for steam and heat	465,701		Minnesota	65,094	
Sold to local trade, not shipped	1,916,188		New York	115,221	
Made into coke at mines	1,217		Pennsylvania	17,075	
Shipped to Ohio points	7,280,390		West Virginia	15,500	
			Wisconsin	10,428	
Total used in Ohio	9,663,496	43.0	Total shipped to other States (all rail)	2,317,036	10.0
Shipped to other States:			Shipped to Great Lakes for cargo	2,482,615	11.0
Illinois	287,561		Exported by rail	60,811	0.9
Indiana	350,251		Shipped to tidewater	15,000	0.1
Iowa	1,666		Used by railroads	7,895,733	35.0
Kentucky and South Dakota	371				
Michigan	1,453,869		Total production	22,434,691	100.0

OKLAHOMA.

More than 2,570,000 tons, or 69 per cent, of the coal mined in Oklahoma in 1915 was used by railroads, and about 722,500 tons of the remainder, or 20 per cent of the output, was consumed in the State. Except that shipped to Texas, 381,000 tons, but little commercial coal from Oklahoma reached outside markets.

Distribution of coal produced in Oklahoma in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Oklahoma:			Shipped to other States—Continued.		
Used at mines for steam and heat	247,565		Missouri	3,653	
Sold to local trade, not shipped	39,482		Texas	381,131	
Shipped to Oklahoma points	435,508		Total shipped to other States	397,275	11
Total used in Oklahoma	722,555	20	Used by railroads	2,573,750	69
Shipped to other States:			Total production	3,693,580	100
Arkansas	453				
Kansas	12,038				

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OREGON.

The only producing coal field in Oregon is on Coos Bay, an arm of the Pacific Ocean, and has no outlet except by water. A small railroad near Coos Bay, the steamships that call at the harbor, and some local industries are the only markets. The coastwise shipments to San Francisco in 1915 were 358 net tons.

Distribution of coal produced in Oregon in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Oregon:			Shipped to tidewater	1,916	5
Used at mines for steam and heat	6,817		Used by railroads	5,000	13
Sold to local trade, not shipped	2,272		Total production	39,231	100
Shipped to Oregon points	23,226				
Total used in Oregon	32,315	82			

PENNSYLVANIA.

The greatest coal-producing State, Pennsylvania, is also the greatest coal-consuming State. Doubtless other factors than the quantity and accessibility of its coal have influenced to some degree the location within its boundaries of the countless industries that now add to its wealth, but it is doubtful whether any other factor has been so potent. In 1915 nearly 60,000,000 net tons of bituminous coal—38 per cent of the output of Pennsylvania in that year—was consumed within the State in making coke and in manufacturing and mining. More than 40,000,000 tons, or 26 per cent of the total, was shipped to other States by rail for uses other than as railroad fuel. About 14,400,000 tons were used in New York, 7,200,000 tons in Ohio, 6,500,000 tons in New England, and nearly 3,500,000 tons in New Jersey. Between 1,000,000 and 2,000,000 tons each were shipped to Maryland, Illinois, and Michigan, and the remainder was used in 25 other States, from the Pacific coast to the South Atlantic States. In 1915 the shipments to the Great Lakes for cargo were more than 9,600,000 tons, or 6 per cent of the output, the shipments to tidewater were 13,960,000 tons, or 9 per cent, and the exports by rail to Canada were 3,866,406 tons, or 2 per cent. Nearly 34,200,000 net tons was used by railroads, of which 3,436,000 tons was consumed in the Great Lakes region and shipped by the Lakes.

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Distribution of bituminous coal produced in Pennsylvania in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Pennsylvania:			Shipped to other States—Continued.		
Used at mines for steam and heat	3,048,515		Nebraska	24,963	
Used at mines for making coke	32,498,370		New England	6,587,890	
Sold to local trade, not shipped	3,231,909		New Jersey	3,489,656	
Shipped to Pennsylvania points	21,214,848		New Mexico	29	
Total used in Pennsylvania	59,993,642	38	New York	14,430,879	
Shipped to other States:			North and South Carolina	305	
Arkansas	86		North Dakota	380	
California	5,324		Ohio	7,197,013	
Colorado	96		Oklahoma	96	
Delaware	951,419		Oregon	126	
District of Columbia and Maryland	1,514,354		Tennessee	30,613	
Idaho	33		Texas	239	
Illinois	1,677,186		Virginia	51,064	
Indiana	855,259		West Virginia	175,000	
Iowa	66,973		Wisconsin	142,694	
Kansas	1,333		Total shipped to other States (all rail)	40,220,496	26
Kentucky	131,101		Shipped to Great Lakes for cargo	[a] 9,619,701	6
Louisiana	478,011		Shipped to tidewater	13,960,000	9
Michigan	1,948,235		Exported by rail	3,866,406	2
Minnesota	120,244		Used by railroads (shipped rail)	[b] 30,294,892	19
Mississippi	45,075		Total production	157,955,137	100
Missouri	294,820				

[a] Includes 3,435,693 tons used for railroad fuel in the northwest.
[b] The total quantity used for railroad fuel was 34,175,299 tons, or 21.6 per cent of the total production.

TENNESSEE.

The coal fields of Tennessee are surrounded by competing fields and a comparatively small proportion of their output reaches markets outside the State. Including coal made into coke but excluding railroad fuel, 1,340,000 tons, or 23 per cent of the output, was used within the State in 1915. The coal shipped to other States amounted to about 1,000,000 tons, or 18 per cent of the output, and that sold for railroad fuel was more than 3,370,000 tons, or 59 per cent of the total production. The "Jellico" coal, mined in northeastern Tennessee, is a favorite domestic fuel in the Southern States. About three-fourths of the coal from Tennessee that is sold in other States went to markets on the south and southeast and the remainder was sold in Indiana, Kentucky, Michigan, Ohio, and Texas. The large percentage of Tennessee coal used by railroads indicates the extent to which the industry in this State depends on the demands of the railroads, and the decline in the production of coal in Tennessee during the last six years is generally attributed to decrease in that demand.

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Distribution of coal produced in Tennessee in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Tennessee:			Shipped to other States—Continued.		
Used at mines for steam and heat	167,560		Indiana	22,590	
Sold to local trade, not shipped	71,071		Kentucky	185,580	
Made into coke at mines	316,138		Michigan	240	
Shipped to Tennessee points	785,968		North Carolina and South Carolina	168,512	
			Ohio	23,974	
			Texas	56,168	
Total used in Tennessee	1,340,737	23	Total shipped to other States	1,014,163	18
Shipped to other States:			Used by railroads	3,375,461	59
Alabama	48,942				
Florida	26,886		Total production	5,730,361	100
Georgia	481,271				

TEXAS.

There is no record that any coal, except, possibly, that used for railroad fuel, was shipped from Texas to other States in 1915. One-half of the output was used by railroads and the greater part of the remainder was consumed within the State. A small quantity was exported to Mexico and 100,000 tons was shipped to tidewater, presumably nearly all for bunker coal for steamships.

Distribution of coal produced in Texas in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Texas:			Exported by rail	78,203	3
Used at mines for steam and heat	59,356		Shipped to tidewater	100,000	5
Sold to local trade, not shipped	13,266		Used by railroads	1,037,249	50
Shipped to Texas points	800,834		Total production	2,088,908	100
Total used in Texas	873,456	42			

UTAH.

The greater part of the coal produced in Utah is used within the State. Including that made into coke, part of which product is, however, shipped to other States, the State used 61 per cent of its own production in 1915. The railroads used a comparatively small part, and, except that shipped to California, Idaho, and Nevada, which are natural markets for coal from Utah, little was used in other States.

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Distribution of coal produced in Utah in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Utah:			Shipped to other States—Continued.		
Used at mines for steam and heat	104,304		Nevada	169,928	
Sold to local trade, not shipped	47,224		Oregon	30,755	
Made into coke at mines	654,387		Washington	32,039	
Shipped to Utah points	1,097,834		Wyoming	50	
Total used in Utah	1,903,749	61	Total shipped to other States	639,477	21
Shipped to other States:			Used by railroads	565,489	18
California	161,987		Total production	3,108,715	100
Idaho	227,417				
Montana	17,301				

VIRGINIA.

The coal produced in Virginia, all of high grade, is widely distributed. One-fourth of the product in 1915 was used in Virginia, in part for making coke; 35 per cent was shipped by rail to 18 other States for domestic and industrial uses, 9 per cent was shipped to tidewater, and 31 per cent was used for railroad fuel.

The largest market for coal from Virginia is in the South. In 1915 more than 2,200,000 tons were shipped to the Carolinas, Georgia, Florida, Alabama, and Tennessee. About 470,000 tons were sold in Michigan, Ohio, Indiana, and Illinois, and 76,891 tons reached States north, northwest, and west of Illinois.

Distribution of coal produced in Virginia in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Virginia:			Shipped to other States—Continued.		
Used at mines for steam and heat	135,799		Minnesota	47,000	
Sold to local trade, not shipped	82,210		Missouri	1,500	
Made into coke at mines	955,352		North Carolina and South Carolina	1,366,943	
Shipped to Virginia points	829,983		North Dakota	15,391	
Total used in Virginia	2,004,344	25	Ohio	169,432	
Shipped to other States:			South Dakota	4,000	
Alabama	67,961		Tennessee	373,244	
Maryland and District of Columbia	3,913		Texas	54,300	
Florida	40,230		Wisconsin	9,000	
Georgia	368,751		Total shipped to other States (all rail)	2,824,961	35
Illinois	120,300		Shipped to tidewater	766,575	9
Indiana	152,291		Used by railroads	2,526,716	31
Iowa	1,500		Total production	8,122,596	100
Michigan	29,205				

WASHINGTON.

Local markets and the railroads together consumed 86 per cent of the coal produced in Washington in 1915. A small quantity—about

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8 per cent of the output—was shipped to Idaho and Oregon, and the remainder was shipped to tidewater. The tidewater movement amounted to 150,071 net tons, of which 12,171 tons was exported to foreign countries, 89,232 tons was used for bunker fuel in the domestic trade, 47,316 tons was used for foreign bunker fuel, and 1,352 tons was shipped by vessel to San Francisco.

Distribution of coal produced in Washington in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Washington:			Shipped to other States:		
Used at mines for steam and heat	126,047		Idaho	25,000	
Sold to local trade, not shipped	64,707		Oregon	172,000	
Made into coke at mines	149,290		Total shipped to other States (all rail)	197,000	8
Shipped to Washington points	592,444		Shipped to tidewater	150,071	6
Total used in Washington	932,488	39	Used by railroads	1,149,446	47
			Total production	2,429,095	100

WEST VIRGINIA.

The coal industry of West Virginia has been developed under unique conditions. There has been little home market, so the operators had to seek markets for their coal in other parts of the United States and in foreign countries. Immense reserves of high-grade coal in easily workable beds have permitted mining on a large scale and at low cost. Proximity to the Atlantic seaboard, where good harbors afford opportunity for foreign and coastwise shipments, and excellent railroad outlets to the markets of the West and Northwest have enabled the coal industry of the State to develop at a rapid rate.

Including the coal made into coke at the mines and that used for steam and heat at the mines, the consumption of West Virginia coal in that State in 1915 was but 6,000,000 net tons, or 8 per cent of the total output. More than 32,500,000 net tons, or 42 per cent of the output, was shipped to other States by rail or by river, for use other than as railroad fuel. The shipments to the Great Lakes for cargo were 8,700,000 net tons, or 11 per cent of the total, and shipments to tidewater were more than 20,400,000 tons, or 27 per cent of the output. The Lake cargo shipments included 800,134 tons for railroad use in the Northwest, and the tidewater shipments included 1,776,419 tons sent by vessels coastwise to New England and used there by the railroads. The quantity of railroad fuel that reached its destination by all-rail routes was 9,478,401 net tons, or 12 per cent of the production in 1915. The total quantity of West Virginia coal used by railroads in 1915 was 12,054,954 net tons, or 15.7 per cent of the total output.

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Distribution of coal produced in West Virginia in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in West Virginia:			Shipped to other States—Continued.		
Used at mines for steam and heat	1,141,178		Nebraska	1,553	
Used at mines for making coke	1,995,279		Nevada	300	
Sold to local trade, not shipped	1,091,371		New Jersey	645,600	
Shipped to West Virginia points	1,772,289		New Mexico	50	
Total used in West Virginia	6,000,117	8	New York	2,072,670	
Shipped to other States:			North and South Carolina	977,782	
Alabama	2,800		North Dakota	425	
Arizona	450		Ohio	5,375,560	
California	17,250		Pennsylvania	4,945,295	
New England	20,419		South Dakota	10,833	
Delaware	245,451		Tennessee	1,305	
District of Columbia and Maryland	814,379		Texas	2,281	
Florida	31,980		Utah	165	
Georgia	41,332		Virginia	2,228,268	
Illinois	5,079,032		Wisconsin	839,105	
Indiana	4,072,001		Total shipped to other States (all rail)	32,555,406	42
Iowa	159,444		Shipped to Great Lakes for cargo	[a] 8,702,172	11
Kansas	390		Shipped to tidewater	[b] 20,405,060	27
Kentucky	443,407		Exported by rail	42,913	0.0
Michigan	4,326,412		Used by railroads (shipped all rail)	[c] 9,478,401	12
Minnesota	40,704		Total production	77,184,069	100
Missouri	158,763				

[a] Includes 800,134 tons used as railroad fuel in the Northwest.
[b] Includes 1,776,419 tons used as railroad fuel in New England.
[c] The total quantity used for railroad fuel was 12,054,954 tons, or 15.7 per cent of the total production.

WYOMING.

The important coal fields of Wyoming are so situated with regard to transportation routes that the coal reaches markets in all adjoining States as well as those in nine distant States, such as Iowa and Missouri. In 1915 coal from Wyoming reached 14 States, and the quantity sold in these States was 1,720,000 tons, or 26 per cent of the output. Montana, Nebraska, South Dakota, Oregon, and Washington received the greater part of the shipments. The largest single market for Wyoming coal is the railroads, which took 65 per cent of the output in 1915, a fact that indicates the extent to which the prosperity of the coal industry of the State is dependent on the prosperity of the great western railroads. There are large possibilities for the coal industry of Wyoming in the home market, which, in 1915, consumed less than 5 per cent of the production.

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Distribution of coal produced in Wyoming in 1915.

	Quantity (net tons).	Percentage of total.		Quantity (net tons).	Percentage of total.
Used in Wyoming:			Shipped to other States—Con.		
Used at mines for steam and heat	256,932		Montana	594,602	
Sold to local trade, not shipped	71,885		Nebraska	363,418	
Shipped to Wyoming points	280,729		Nevada	44,523	
			North Dakota	96,558	
			Oregon	106,787	
			South Dakota	152,350	
			Utah	74,788	
Total used in Wyoming	609,546	9	Washington	100,277	
Shipped to other States:			Total shipped to other States	1,721,011	26
California	43,546				
Colorado	101				
Idaho	87,619		Used by railroads	4,223,290	65
Iowa	16,418		Exported by rail	181	0.0
Kansas	38,540				
Missouri	1,484		Total production	6,554,028	100

DISTRIBUTION OF PENNSYLVANIA ANTHRACITE.

Pennsylvania anthracite is the fuel most generally used for heating in the United States. Although complete data are lacking, an estimate made from partial statistics showing the purposes for which the anthracite produced in 1915 was used and from statistics showing the quantities of different sizes produced indicates that not less than 50,000,000 net tons of anthracite was used in heating households, apartment houses, hotels, and office, school, and other buildings. About 71,000,000 net tons of bituminous coal was used in the domestic and small steam trade in 1915 (see p. 472), and probably less than 60,000,000 tons of that quantity was used for heating for the comfort of man. Doubtless more persons depend on anthracite than on bituminous coal for heating, for anthracite is used to the greatest extent in the part of the United States that lies north of Virginia and east of western Pennsylvania, a region in which the population is densest and housing most congested. Although its high price and the high cost of transportation make it more or less a luxury in territory farther from its source, anthracite was shipped to nearly every State in the Union, the only exceptions in 1915, according to the reports received by the Geological Survey, being Arizona, Nevada, New Mexico, and Utah. In the territory outside of the New England States, Pennsylvania, New York, and New Jersey, to which more than 80 per cent of the output (including that used by railroads) is shipped for consumption, the States using the greatest quantities of Pennsylvania anthracite are Illinois, where (mainly at Chicago) more than 3,000,000 tons was consumed in 1915, Wisconsin and Minnesota, which obtain their supply almost entirely by way of the Great Lakes, Maryland, and the District of Columbia.

The total shipments to the North Central States were 10,504,000 net tons, of which 4,622,000 tons was sent by way of the Great Lakes and the remainder, 5,882,000 tons, by all-rail routes. Nearly every State in that region received more than 300,000 tons.

The shipments to the South Atlantic and Southern States were 2,161,000 net tons, the greater part of which went to Maryland, the District of Columbia, Delaware, North Carolina, South Carolina, and Virginia. The shipments to that region were made by all-rail routes.

Quantities of anthracite ranging from 200 to 5,000 tons were shipped to the States of the Rocky Mountain and Pacific coast

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regions. The following table shows the distribution of the shipments in 1915:

Distribution of Pennsylvania anthracite in 1915.

	Shipped by way of tidewater (net tons).	Shipped by way of Great Lakes (net tons).	Shipped by rail only (net tons).	Total (net tons).	Percentage of total.
Middle Atlantic States:					
Pennsylvania—					
Used at mines for steam and heat				9,996,544	
Sold to local trade, not shipped				2,092,086	
Shipped to Pennsylvania points			11,203,954	11,203,954	
				23,292,584	
New York			20,789,494	20,789,494	
New Jersey			8,375,000	8,375,000	
			40,368,448	52,457,078	58.9
New England States	5,500,000		8,267,000	13,767,000	15.5
South Atlantic and Southern States:					
Alabama			8,100	8,100	
Arkansas			800	800	
Delaware			210,000	210,000	
District of Columbia and Maryland			1,470,000	1,470,000	
Florida			25,000	25,000	
Georgia			50,000	50,000	
Kentucky			20,000	20,000	
Louisiana			15,000	15,000	
Mississippi			2,000	2,000	
North and South Carolina			124,000	124,000	
Oklahoma			500	500	
Tennessee			9,000	9,000	
Texas			22,000	22,000	
Virginia			170,000	170,000	
West Virginia			35,000	35,000	
			2,161,400	2,161,400	2.4
North Central States:					
Illinois		807,000	2,485,000	3,292,000	
Indiana			600,000	600,000	
Iowa			310,000	310,000	
Kansas			25,000	25,000	
Michigan		45,000	793,800	838,800	
Minnesota		1,600,000	70,000	1,670,000	
Missouri			371,300	371,300	
Nebraska		30,000	497,300	527,300	
North Dakota		310,000	50,000	360,000	
Ohio			600,000	600,000	
South Dakota		150,000	30,000	180,000	
Wisconsin		1,690,000	50,000	1,730,000	
		4,622,000	5,882,400	10,504,400	11.8
Western States:					
California			500	500	
Colorado			600	600	
Idaho			200	200	
Montana			5,000	5,000	
Oregon			200	200	
Washington			1,900	1,900	
Wyoming			200	200	
			8,600	8,600	
Total distributed in United States for purposes other than railroad fuel				78,898,478	
Used for railroad fuel				6,200,000	7.0
Total distributed in United States				85,098,478	
Exported to Canada				3,852,894	
Exported to other countries				112,361	
Total exported				3,965,255	4.4
Total distribution, 1915				89,063,733	100.0
Total production, 1915				88,995,061	

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These statistics were compiled from reports furnished by companies producing, selling, and distributing anthracite and by railroads; from statements given elsewhere in this report, particularly in connection with the reviews of coal trade in large cities; and from reports of the United States Army engineers. For some of the items in the table complete figures were available, but for others estimates were made by the writer, the estimates for some items covering as much as 10 per cent of the quantity reported. The figures showing the tidewater shipments to New England, the consumption by railroads, the all-rail shipments to States, and the shipments by the Lakes to the middle northwest are fairly accurate. The figures showing the distribution among the States of the coal shipped by the Lakes are, however, only approximate. The figures showing exports were taken from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Although used elsewhere in this report (p. 479) to represent consumption, these statistics actually show distribution. The distinction is important, particularly as regards anthracite, because large quantities of it are stored. The anthracite interests reported that during 1915 the piles of stored anthracite were increased by 5,000,000 to 10,000,000 gross tons. The statistics of distribution were obtained from shippers rather than from consumers, and it appears that much coal which has been reported as shipped to certain States, notably to New York, Pennsylvania, New Jersey, and possibly to New England States, in which there are large storage yards, has been consigned to storage, so that the consumption of anthracite in those States was less than the quantity shown in the accompanying table by the number of tons the stocks were increased.

A further element of inaccuracy may be involved in the fact that coal may have been consigned to a storage plant, for instance, in New York State, and so reported to the Geological Survey, and later in the year may have been removed and shipped to other States, but as the production in 1915 was greater than the consumption, and as storage piles were being increased throughout the year rather than cut down, it is not likely that the statistics are greatly affected by this factor.

EXPORTS.

The exports of bituminous coal from the United States in 1915 were 18,776,640 net tons, an increase, compared with 1914, of 3,318,568 tons, or 21 per cent, but less than the exports in 1913, which were 20,145,168 tons. The increase was due to larger shipments to Europe and to South America, as the exports to Canada, the largest user of coal from the United States, decreased about 8 per cent. The bituminous coal shipped to Canada in 1913 was 74 per cent; in 1914, 67 per cent; and in 1915 but 50 per cent of the total exports.

The noteworthy features of the export trade in 1915 were the increasing demand throughout the year from Europe and South America and, in the later part of the year, the scarcity of vessels in which to ship coal to these countries. If the supply of vessels had been adequate the exports undoubtedly would have been much greater.

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Exports of Pennsylvania anthracite decreased from 4,289,873 net tons in 1914 to 3,965,255 net tons in 1915. The exports of anthracite to Canada in 1915 were 3,852,894 net tons, a decrease, compared with 1914, of about 9 per cent.

The following tables have been prepared from the records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce. The statistics show foreign cargo coal only; the quantities of steamship or bunker coal are given elsewhere in this report.

Coal exported from the United States in 1915.

By countries.

	Anthracite.		Bituminous.	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.
Azores, Madeira, etc.			11,882	$29,924
Denmark	95	$510	2,999	8,031
France	220	1,086	251,811	700,443
Greece	1,002	4,939	82,025	219,049
Italy	27,965	131,320	3,283,371	8,679,707
Netherlands			42,800	107,947
Norway			58,830	139,236
Portugal			22,118	60,462
Serbia, Montenegro, etc.			160	460
Spain	1,374	6,417	223,586	615,597
Sweden	4,798	21,420	263,345	625,946
England	1	6	3,809	12,566
Ireland	358	1,660	700	2,125
Bermuda	2,885	11,733	30,161	83,215
British Honduras			429	1,336
Canada	3,852,894	17,935,407	9,356,872	17,701,164
Costa Rica	85	503	25,133	56,732
Guatemala	48	309	16,264	38,380
Honduras	69	551	20,558	53,177
Nicaragua			1,074	3,443
Salvador	7	52	26	230
Greenland			897	2,203
Panama	671	3,779	577,182	1,400,881
Mexico	757	4,634	312,495	1,237,153
Miquelon, etc.	607	2,942		
Newfoundland, etc.	14,020	63,315	2,518	7,284
Barbados	195	1,205	98,285	267,225
Jamaica	249	1,481	49,528	132,597
Trinidad, etc.	288	1,516	97,772	279,452
Other British West Indies	672	3,222	119,705	317,253
Cuba	37,679	141,997	1,305,776	3,274,890
Danish West Indies			29,630	83,112
Dutch West Indies	209	1,075	63,050	170,133
French West Indies			95,150	263,002
Haiti	40	266	797	2,263
Dominican Republic	8,709	40,542	15,043	47,709
Argentina	2,830	15,493	881,403	2,378,381
Brazil	2,705	9,518	726,089	1,942,088
Chile	1,089	5,451	80,117	209,441
Colombia	177	986	4,425	10,879
British Guiana	114	682	22,549	62,214
Dutch Guiana			7,862	21,996
Peru	199	1,194	16,681	42,210
Venezuela	1,496	10,246	9,456	27,287
Equador			6,741	16,504
Uruguay	678	3,367	177,185	463,208
British West Africa			12,264	29,215
Dutch East Indies			18,101	47,279
Canary Islands	21	145	26,862	71,504
Egypt			178,436	487,086
French Africa			123,306	333,195
Morocco			7,233	17,905
Portuguese Africa	1	8	12,138	32,509
Australia	48	278		
Other British Oceania			11	113
	3,965,255	18,429,255	18,776,640	42,817,341

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Coal exported from the United States in 1915—Continued.

By customs districts.

	Anthracite.		Bituminous.	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.
Hawaii			11	$113
Maine and New Hampshire	10,641	$53,613	120	586
Maryland	3,533	17,778	2,129,642	5,549,472
Massachusetts	1,259	7,849	160	710
New York	220,931	991,226	37,092	116,513
Philadelphia	96,846	401,421	1,166,858	3,045,222
Porto Rico			1,995	11,259
South Carolina			7,293	19,537
Virginia	690	4,069	5,804,787	15,240,981
Florida	422	1,897	1,909	6,205
Mobile	72	568	6,599	18,212
New Orleans	215	1,200	12,132	39,471
Sabine	103	640		
Arizona	2	30	33,188	108,203
Eagle Pass			524	2,000
El Paso			196,020	876,033
Laredo			23,502	83,542
San Francisco	7	85	479	4,076
Southern California	67	729	286	2,221
Washington	85	594	12,171	36,343
Buffalo	1,859,892	8,622,277	2,485,631	4,995,579
Dakota	15,688	96,830	43,602	113,713
Duluth and Superior	8,453	46,820	43,119	108,061
Michigan	303	943	613,377	1,035,526
Ohio	64,419	296,003	5,204,817	9,347,791
Rochester	606,631	2,933,440	645,671	1,457,323
St. Lawrence	1,063,904	4,902,695	300,418	590,036
Vermont	12,092	48,548	5,150	7,408
Alaska			87	1,185
	3,965,255	18,429,255	18,776,640	42,817,341

Coal exported from the United States, 1910–1915.

	Anthracite.		Bituminous.	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.
1910	3,384,222	$14,785,387	12,078,348	$26,685,405
1911	3,980,479	18,093,285	15,544,204	34,499,989
1912	4,131,444	19,425,263	16,195,175	36,817,633
1913	4,652,912	21,959,850	20,145,168	45,449,664
1914	4,289,873	20,211,072	15,458,072	34,104,903
1915	3,965,255	18,429,255	18,776,640	42,817,341

The following table shows the exports of bituminous coal according to the States in which it was produced. The data from which the table has been compiled are not complete, particularly as regards the division between Pennsylvania and West Virginia, but the figures are the best that are available.

The exports from Alabama and Washington are shipped from tidewater points, and the exports from Colorado, Kentucky, New Mexico, Texas, and North Dakota are shipped by all-rail routes to Canada and Mexico. A small quantity of the exports from Maryland was shipped by rail to Canada and the remainder by vessel from Baltimore. The exports from Ohio were shipped mainly by way of the

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Great Lakes and are included in the Lake cargo shipments from the State shown elsewhere in this report. A small quantity of Ohio coal was exported to Canada by rail. The coal exported from Pennsylvania was shipped by vessel from the harbors at New York, Philadelphia, and Baltimore, and the harbors on Lake Huron and Lake Erie, by rail to Canada through Buffalo and, to a small extent, from points in New England. The greater part of the coal exported from West Virginia and Virginia was loaded on vessels at Hampton Roads, a small quantity was loaded on vessels at Baltimore, and about 43,000 net tons was shipped to Canada by rail. About 2,000,000 tons of coal was shipped from West Virginia to Canada by way of the Great Lakes, either directly to Canadian points by vessel, or by rail from the head of the Lakes. The exports from Virginia were loaded on vessels at Charleston, S. C., and Hampton Roads, Va.

Bituminous coal exported from the United States, 1915.

	Net tons.		Net tons.
Alabama	23,641	Washington	12,171
Colorado and Kentucky	93,645	West Virginia and Virginia	8,951,844
Maryland	515,538	Wyoming	181
New Mexico	155,030	Unspecified[1]	2,858
Ohio	663,811		
Pennsylvania	8,279,718		18,776,640
Texas	78,203		

IMPORTS.

The imports of both bituminous coal and anthracite into the United States are small. The largest markets for foreign coal in this country are the New England States, the northwest States bordering on Canada, and California. Coal from Nova Scotia is used in New England and coal from Vancouver Island and Alberta is used in the Northwest. The figures in the following tables were compiled from the records of the Bureau of Foreign and Domestic Commerce, of the Department of Commerce.

The total imports of bituminous coal in 1915 were 1,709,205 net tons, of which 654,703 tons, or 38 per cent, was entered in New England; $432,721 tons, or 25 per cent, was entered in Montana and Idaho; and 413,225 tons, or 24 per cent, was received at Pacific coast ports. Imports of bituminous coal at Hawaii were 160,330 tons, and at Alaska 29,457 tons.

Bituminous coal imported into the United States in 1915.

Customs district.	Quantity (net tons)	Value.	Customs district.	Quantity (net tons).	Value.
Alaska	29,457	$124,873	New York	12,176	$37,238
Buffalo	1,319	3,544	Oregon	793	2,647
Dakota	1,626	1,807	Philadelphia	991	4,485
Florida	515	1,955	San Francisco	274,564	787,377
Galveston	392	1,650	Southern California	9,661	30,894
Hawaii	160,330	378,499	Vermont	9,427	24,790
Maine and New Hampshire	143,833	310,930	Virginia	661	875
Maryland	252	773	Washington	128,207	476,140
Massachusetts	501,443	1,189,326			
Michigan	837	1,712		1,709,205	4,410,772
Montana and Idaho	432,721	1,031,257			

[1] Includes exports reported by the Bureau of Foreign and Domestic Commerce from the districts of Porto Rico, Hawaii, San Francisco, southern California, and Alaska.

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Anthracite imported into the United States in 1915.

Customs district.	Quantity (net tons).	Value.
Maine and New Hampshire	24	$160
Michigan	48	239
Oregon	661	3,047
Vermont	49	580
Washington	32	198
	814	4,224

Coal imported and entered for consumption in the United States, 1910–1915.

	Anthracite.		Bituminous.	
	Quantity (net tons).	Value.	Quantity (net tons).	Value.
1910	9,180	$42,244	2,224,609	$4,761,223
1911	2,759	12,550	1,383,198	3,604,797
1912	1,870	8,329	[a] 1,798,578	4,509,066
1913	1,004	5,620	[a] 1,582,557	3,853,930
1914	17,696	25,380	[a] 1,545,828	3,902,881
1915	814	4,224	[a] 1,709,205	4,410,772

[a] Includes 510,257 net tons of slack or culm (value, $901,051) passing ¼-inch screen in 1912; 394,248 tons (value, $689,864) in 1913; and 184,433 tons (value, $303,348) in 1914; and 232,891 tons (value $491,731) in 1915.

CONSUMPTION OF BITUMINOUS COAL AND LIGNITE, BY INDUSTRIES, ACCORDING TO SOURCES.

GENERAL STATEMENT.

The coals produced in the United States are of many kinds and are used for many purposes. Certain kinds are in demand for particular uses, as cannel coal for open fireplaces, Cumberland or Georges Creek for blacksmithing, and Connellsville for coking in beehive ovens. West Virginia splint and Jellico (Tennessee) coals are well known as domestic fuels, and Pocahontas and Somerset as steam coals. The physical and particularly the chemical properties of a coal now largely determine the use for which it is adapted, although not all the old-time prejudices of the consumer have yet been overcome by the advance of modern ideas on the scientific purchase and utilization of coal. The quantities of coal from each State used for different purposes are shown in the accompanying table, which, however, indicates only the more important uses and those for which statistics are available. Small quantities of bituminous coal are used as blast-furnace fuel, as reduction material in zinc smelting, in the chemical and electrochemical industries, in pulverized form for foundry facing, and in other ways.

Bituminous coal is, of course, used principally for steam raising. The coal used by industrial steam plants, by railroads, by steamships, by the coal mines, and exported amounted to about 305,000,000 tons, or 70 per cent of the production in 1915, all used for making steam. Of that quantity, about 144,000,000 tons, or 33 per cent of the total, was used by industrial steam plants and presumably for all general purposes in the industries, as in making producer gas and burning

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cement, and 122,000,000 net tons, or 28 per cent of the total, was consumed by the railroads. More than 71,000,000 tons, or 16 per cent of the output of bituminous coal, was taken by the domestic and small-steam trade and used for heating dwellings, apartment houses, hotels, and office buildings, and for heating and steam raising in small power plants.

The distinction between industrial steam trade and domestic and small-steam trade is, of course, largely arbitrary. The statistics given in the following table are based on figures or estimates furnished by the producing companies and the selling or distributing agents, most of whom, however, were not able to show exactly the division of their product between these classes of use, because before it reached the consumers the coal was in turn handled by brokers and wholesale and retail dealers.

In order of magnitude as a consumer of bituminous coal, the coke industry ranks third, more than 61,500,000 tons, or 14 per cent of the output, having been used in 1915 in making coke. About 4 per cent was exported, 2 per cent was used at the coal mines for generating steam and heat, and 1 per cent was used in making coal gas for municipalities. Special industries, such as blacksmithing, used 714,000 tons, or about 0.1 per cent.

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Distribution of bituminous coal and lignite produced in the United States and imported, 1915, by uses.

State in which coal was produced.	Railroad fuel.		Steamship bunker fuel—Tidewater.[a]		Steamship bunker fuel—Great Lakes.[b]		Manufacture of beehive coke.		Manufacture of by-product coke.		Manufacture of coal gas.[c]	
	Quantity (net tons).	Per cent.	Quantity (net tons).	Per cent.	Quantity (net tons).	Per cent.	Quantity (net tons).	Per cent.	Quantity (net tons).	Per cent.	Quantity (net tons).	Per cent.
Alabama	5,072,435	4.0	480,258	5	.....	.....	1,708,228	4.0	2,987,710	15.1	109,160	2.4
Alaska	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Arkansas	803,295	.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
California[d]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Colorado	2,388,515	2.0	.....	.....	.....	.....	1,026,019	2.3	.....	.....	103,674	2.3
Georgia	5,000	.0	.....	.....	.....	.....	35,377	.1	.....	.....	.....	.....
Illinois	18,928,022	16.0	.....	.....	.....	.....	.....	.....	98,073	.5	34,785	.7
Indiana	6,188,550	5.0	.....	.....	.....	.....	.....	.....	.....	.....	60,145	1.3
Iowa	4,415,832	3.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Kansas	3,154,501	2.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Kentucky	4,649,823	3.8	.....	.....	11,879	1	462,168	1.0	1,546,834	7.9	616,936	13.5
Maryland	387,121	.3	76,044	1	.....	.....	.....	.....	156,782	.8	21,000	.5
Michigan	394,921	.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Missouri	2,351,940	2.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Montana	1,050,319	1.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
New Mexico	1,635,752	1.3	.....	.....	.....	.....	732,830	1.7	.....	.....	11,187	.2
North Dakota	3,109	.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ohio	8,206,128	6.7	.....	.....	216,760	15	.....	.....	.....	.....	.....	.....
Oklahoma	2,573,750	2.0	.....	.....	.....	.....	.....	.....	.....	.....	9,553	.2
Oregon	5,000	.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pennsylvania	34,175,299	28.0	5,888,708	64	1,009,484	69	33,972,018	81.0	6,421,707	32.8	2,497,216	55.0
South Dakota	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tennessee	3,375,461	2.7	.....	.....	.....	.....	433,781	1.0	32,084	.2	62,020	1.3
Texas	1,037,249	.9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Utah	565,489	.5	.....	.....	.....	.....	654,387	1.4	.....	.....	49,615	1.0
Virginia	2,826,716	2.0	(e)	.....	.....	.....	995,396	2.2	.....	.....	99,149	2.1
Washington	1,149,446	1.0	.....	.....	.....	.....	158,496	.3	46,383	.2	124,093	2.7
West Virginia	12,054,954	10.0	[f] 2,800,904	30	223,470	15	2,099,816	5.0	7,774,809	40.0	765,046	16.8
Wyoming	4,223,290	3.4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Imports[g]	[h] 378,083	.3	.....	.....	.....	.....	.....	.....	[h] 490,000	2.5	.....	.....
	122,000,000	100.0	9,245,914	100	1,461,593	100	42,278,516	100.0	19,554,382	100.0	4,563,579	100.0
Percentage of total consumption	28.0	.....	2.0	.....	0.3	.....	9.3	.....	4.3	.....	1.0	.....

[a] Includes coal for foreign and domestic bunker at ports only of New York, Philadelphia, Baltimore, Hampton Roads, New Orleans, Mobile, and Pensacola, and Georgia and South Carolina ports.
[b] Includes only vessel fuel taken on at Lake Erie ports, exclusive of Buffalo.
[c] Does not include 81,216 tons the origin of which is not known. The total coal used in the manufacture of coal gas was 4,644,795 tons.
[d] Includes Idaho and Nevada.
[e] Included with West Virginia.
[f] Includes Virginia.
[g] Does not include 841,122 net tons imported, the use of which is not known.
[h] Estimated.

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Distribution of bituminous coal and liginite produced in the United States and imported, 1915, by uses—Continued.

State in which coal was produced.	Domestic and small steam trade.		Industrial steam trade.[a]		Exported.[b]		Used at mines for steam and heat (net tons).	Special uses (net tons.)[c]	Total quantity (net tons).
	Quantity (net tons).	Per cent.	Quantity (net tons).	Per cent.	Quantity (net tons).	Per cent.			
Alabama	1,592,932	2.2	2,389,397	1.7	23,641	0.1	535,340	28,836	14,927,987
Alaska	1,400	.0							1,400
Arkansas	622,734	.9	110,012	.1			62,175	53,890	1,652,106
California[d]	12,203	.0					300		12,503
Colorado	2,350,000	3.3	2,365,019	1.6	[e] 93,645	.5	294,571	3,537	8,624,980
Georgia	6,084	.0	80,835	.1			7,200		134,496
Illinois	17,206,032	24.1	21,029,595	14.7			1,533,069		58,829,576
Indiana	2,789,631	4.0	7,542,334	5.3			425,352	140	17,006,152
Iowa	1,600,763	2.2	1,449,389	1.0			148,159		7,614,143
Kansas	2,203,200	3.1	1,239,302	.8			184,071	43,400	6,824,474
Kentucky	7,148,651	10.0	6,339,370	4.4	(f)		495,313	90,700	21,361,674
Maryland	86,575	.1	2,799,231	2.0	515,538	2.8	64,588	73,598	4,180,477
Michigan	500,498	.7	225,000	.1			35,719		1,156,138
Missouri	1,072,940	1.5	302,622	.2			84,091		3,811,593
Montana	1,212,613	1.7	404,231	.3			122,592		2,780,755
New Mexico	600,000	.8	598,617	.4	155,030	.8	28,868	55,656	3,817,940
North Dakota	448,234	.6					17,499	59,236	528,078
Ohio	3,993,510	5.6	8,888,781	6.0	663,811	3.5	465,701		22,434,691
Oklahoma	585,787	.8	275,665	.2			247,565	1,260	3,693,580
Oregon	27,414	.1					6,817		30,231
Pennsylvania	9,362,800	13.0	53,055,847	37.0	8,279,718	44.2	3,048,515	243,826	157,955,137
South Dakota	10,593	.0							10,593
Tennessee	746,755	1.1	912,700	.6			167,560		5,730,361
Texas	814,100	1.1	100,000	.1	78,203	.4	59,356		2,088,908
Utah	1,127,210	1.6	606,960	.4			104,304	750	3,108,715
Virginia	(g)		(g)		(g)		135,799	59,245	8,122,596
Washington	333,000	.5	479,459	.3	12,171	.1	126,047		2,429,095
West Virginia	[h] 13,159,720	18.5	[h] 32,218,619	22.5	[h] 8,951,844	47.6	1,141,178		77,184,069
Wyoming	1,721,110	2.5	352,515	.2	181	.0	256,932		6,554,028
Imports[i]									868,083
	71,336,489	100.0	143,765,500	100.0	18,773,782	100.0	9,798,681	714,073	443,492,509
Percentage of total consumption	16.0		33.0		4.0		2.0	.1	

[a] Includes also fuel coal for river steamers and all bunker supplies for lake and ocean vessels other than given elsewhere in this table.
[b] Does not include 2,858 net tons reported by the Bureau of Foreign and Domestic Commerce as exported from Porto Rico, Hawaii, San Francisco, southern California and Alaska.
[c] Blacksmithing coal mainly.
[d] Includes Idaho and Nevada.
[e] Includes exports by rail from Kentucky.
[f] Included in exports from Colorado.
[g] Included with West Virginia.
[h] Includes Virginia.
[i] Does not include 841,122 net tons imported, the use of which is not known.

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COAL USED BY RAILROADS.

In 1915 the railroads in the United States used 128,200,000 net tons of bituminous coal and anthracite, or 24 per cent of the output. The quantity of bituminous coal so used was 122,000,000 tons, or 28 per cent of the bituminous output, and the quantity of Pennsylvania anthracite used was 6,200,000 tons, or 7 per cent of the anthracite output. Of that quantity 56,500,000 tons of bituminous coal and all of the anthracite (6,200,000 tons), or 49 per cent, was used by roads in the northeastern part of the country, 22,000,000 tons of bituminous coal, or 17 per cent, was used in the Southern States, and 43,500,000 tons, or 34 per cent, was used in the West.

These statistics were compiled from reports made to the Geological Survey by more than 180 roads of Class I—defined by the Interstate Commerce Commission as roads whose annual gross operating revenues exceed $1,000,000—and from data furnished by many other roads. From information supplied by the railroads showing the quantities of coal used, and from statistics furnished by the Interstate Commerce Commission covering the number of steam-locomotive miles operated, an average consumption of coal per locomotive mile was determined for each district, on the basis of which average estimates were made of the fuel consumed by such of the larger roads as did not report and by all the small roads. The quantity thus estimated was less than 5 per cent of the total. Corrections were made, of course, for miles run electrically and for operations using fuel oil. A check on these figures—only a partial check in some districts—was furnished by the returns received from coal operators and distributors who reported the quantity of their product sold to railroads.

The information requested of the railroad companies included the quantity of coal used and the States or coal fields in which the coal was mined. It is obviously impracticable to show the States in which the railroad fuel was consumed. The following table shows the quantity of railroad fuel received from each State, the district in which it was used, and the total consumed in each district. The districts are those defined by the Interstate Commerce Commission as follows:[1]

For the purposes of this report, the railway companies listed have severally been assigned to three so-called districts, which are defined below. These districts correspond in a general way to the territories covered by the three general freight classifications in use throughout the United States, namely, the official, the southern, and the western.

The eastern district comprises that portion of the United States bounded on the west by the northern and western shore of Lake Michigan to Chicago, thence to Peoria, thence to East St. Louis, thence down the Mississippi River to the mouth of the Ohio River; and on the south by the Ohio River from its mouth to Parkersburg, W. Va., thence to the southwestern corner of Maryland, thence by the Potomac River to its mouth.

The southern district comprises that portion of the United States bounded on the north by the eastern district and on the west by the Mississippi River.

The western district comprises the remainder of the United States, except Alaska and island possessions.

The assignment of carriers to the several districts is necessarily arbitrary in those cases in which carriers operate in more than one of them. The order in which the statistics for the carriers in each district are presented depends upon their rank with respect to operating revenues.

[1] A preliminary abstract of statistics of common carriers for the year ended June 30, 1914, p. 5, Interstate Commerce Commission, 1915.

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The totals representing the quantities of coal used by railroads in the three districts are fairly accurate, as are the quantities so used from each State, but a certain amount of estimating was necessary to divide the quantities from each State among the three districts, and there is no reliable check upon such estimates, so that the details given in the table are not as accurate as the totals.

The coal used for railroad fuel from all States except Ohio, Pennsylvania, Virginia, and West Virginia is either taken by the roads that enter the fields or is delivered to the consuming road by all-rail routes, except possibly that some coal from Pennsylvania and West Virginia which is shipped west and south on Kanawha and Ohio rivers may be used by railroads. The fuel supply for railroads in New England is shipped either by all-rail routes across New York from Pennsylvania and, to a less extent, from Maryland and West Virginia, or by coastwise vessels to New England ports from the terminal piers of railroads that reach the coal fields to the south. Coal from both Virginia and West Virginia was shipped coastwise in this manner from Hampton Roads in 1915 and used by railroads in New England. Likewise railroads reaching the docks at the head of the Great Lakes use coal from all four of these States that is shipped by vessel from lower lake ports.

Coal consumed by railroads in the United States, 1915, in net tons.

State in which coal was produced.	Eastern district.	Southern district.	Western district.	Total.
Alabama		4,897,710	174,725	5,072,435
Arkansas			803,296	803,296
Colorado			2,388,515	2,388,515
Georgia		5,000		5,000
Illinois	5,710,807	1,987,547	11,279,668	18,928,022
Indiana	4,375,204	1,254,713	558,633	6,188,550
Iowa			4,415,832	4,415,832
Kansas			3,154,501	3,154,501
Kentucky	389,546	3,764,355	495,922	4,649,823
Maryland	387,121			387,121
Michigan	394,921			394,921
Missouri	600,000		1,751,940	2,351,940
Montana			1,050,319	1,050,319
New Mexico			1,635,752	1,635,752
North Dakota			3,109	3,109
Ohio:				
Shipped all rail	7,837,124		58,609	
Shipped via lakes			310,395	
Total			369,004	8,206,128
Oklahoma			2,573,750	2,573,750
Oregon			5,000	5,000
Pennsylvania:				
Shipped all rail	29,786,032	126,569	827,005	
Shipped via lakes			3,435,693	
Total			4,262,698	34,175,299
Tennessee		3,375,461		3,375,461
Texas			1,037,249	1,037,249
Utah			565,489	565,489
Virginia:				
Shipped all rail	300,000	2,226,716		
Shipped via tidewater	300,000			
Total	600,000			2,826,716
Washington			1,149,446	1,149,446

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Coal consumed by railroads in the United States, 1915, in net tons—Contd.

State in which coal was produced.	Eastern district.	Southern district.	Western district.	Total.
West Virginia:				
Shipped all rail	4,492,029	4,411,929	574,443	
Shipped via Lakes			800,134	
Shipped via tidewater	1,776,419			
Total	6,268,448		1,374,577	12,054,954
Wyoming			4,223,290	4,223,290
Imports	150,797		227,286	378,083
Total bituminous coal	56,500,000	22,000,000	43,500,000	122,000,000
Pennsylvania anthracite	6,200,000			6,200,000
Grand total	62,700,000	22,000,000	43,500,000	128,200,000

COAL USED BY STEAMSHIPS.

Complete statistics showing the quantity of coal used for bunkering vessels are difficult to obtain. Prior to 1915 the Bureau of Foreign and Domestic Commerce collected such statistics for both foreign and domestic commerce, but the only complete figures available for 1915 are those for foreign commerce. From these figures and from incomplete returns for coal used by vessels engaged in domestic trade, supplemented by estimates based on other sources of information, the total quantity of bituminous coal bunkered by vessels at ports of the United States in 1915, exclusive of Lake Erie ports, was about 11,780,000 net tons. This includes small quantities of coal supplied to vessels at points as distant as Porto Rico, Alaska, and Hawaii. Of the total, 8,367,507 tons are reported by the Bureau of Foreign and Domestic Commerce as used by vessels engaged in foreign trade, and the remainder, about 3,410,000 tons, was used by vessels engaged in domestic trade. The place of origin of about 9,245,000 tons of this coal has been ascertained and is shown in the table on page 471. That quantity was loaded on vessels at the ports shown in the following table:

Bunker coal supplied to vessels engaged in foreign and domestic commerce at certain ports in 1915.

	Net tons.		Net tons.
New York[1]	4,110,400	Mobile, Pensacola, and South Carolina and Georgia ports	364,053
Philadelphia	929,036		
Baltimore	886,396		
Hampton Roads	2,351,956		
New Orleans	604,073		9,245,914

[1] Does not include 280,000 tons estimated to have been supplied at New York Harbor directly from coastwise barges to steamships.

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The bunker coal supplied to vessels engaged in foreign trade in 1915, according to the records of the Bureau of Foreign and Domestic Commerce, is given in the following table:

Fuel or bunker coal supplied to steamers engaged in foreign trade at ports of the United States in 1915.

Customs district.	Quantity (net tons).	Value.	Customs district.	Quantity (net tons).	Value.
Georgia	52,301	$194,040	Alaska	130	$1,897
Maine and New Hampshire	8,346	40,954	Hawaii	69,556	555,904
Maryland	653,665	1,771,236	Oregon	3,517	17,020
Massachusetts	155,725	572,184	San Francisco	128,631	809,177
New York	3,667,265	10,463,731	Washington	47,316	168,335
North Carolina	3,838	16,067	Buffalo	44,299	114,441
Philadelphia	479,036	1,278,167	Chicago	23,581	64,981
Porto Rico	26,764	135,053	Duluth	2,602	9,080
South Carolina	8,904	32,595	Michigan	41,507	129,992
Virginia	1,907,927	5,591,349	Ohio	187,647	443,752
Florida	117,261	446,286	Rochester	34,504	94,917
Texas	48,107	272,334	St. Lawrence	8,319	28,457
Mobile	94,821	255,657	Wisconsin	269	818
New Orleans	546,020	1,656,991		8,367,507	25,192,956
Sabine, Tex	5,649	26,941			

In order to furnish some idea of the quantity of coal supplied to vessels engaged in domestic trade, the following table (also compiled from the records of the Bureau of Foreign and Domestic Commerce), giving the figures for 1914, is presented. The quantity thus used in 1914 was 3,713,441 net tons, compared with an estimated total of 3,410,000 tons in 1915.

Fuel or bunker coal supplied to steamers engaged in domestic trade at ports of the United States in 1914.

Customs district.	Quantity (net tons).	Value.	Customs districts.	Quantity (net tons).	Value.
Alaska	8,558	$93,503	North Carolina	3,623	$15,198
Connecticut	164,458	612,778	Oregon	2,329	7,972
Duluth-Superior	678	2,424	Philadelphia	443,186	1,171,655
Florida	30,552	129,058	Porto Rico	2,408	12,666
Galveston, Tex	11,201	59,691	Rhode Island	24,408	92,334
Sabine, Tex	610	1,358	Rochester	4,586	12,479
Georgia	8,557	11,982	San Francisco	10,843	73,871
Hawaii	18,633	143,968	Southern California	84	233
Maine and New Hampshire	44,383	200,786	St. Lawrence	1,097	3,609
Maryland	285,402	748,420	Virginia	328,464	953,410
Massachusetts	164,485	612,778	Washington	95,957	354,396
Mobile	3,080	10,288	Wisconsin	5,832	16,853
New Orleans	56,396	170,820		3,713,441	8,236,771
New York	993,681	2,724,239			

The quantity of vessel fuel supplied at ports on Lake Erie—1,461,593 net tons—is not included in the foregoing statistics. The origin of that coal is given in the table on page 471.

COAL USED IN MAKING COKE.

The statistics given in the table on page 471, showing the quantity of coal used in making beehive and by-product coke, are taken from the report on coke in 1915,[1] but the table shows also, as nearly as it

[1] See current report on coke: U. S. Geol. Survey Mineral Resources, 1915, pt. 2, pp. 515–558.

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can be ascertained, the States in which the coal used in this industry was mined. All coal coked in beehive ovens, except that so used in Ohio, is considered to have been mined in the State in which it was coked. The statistics showing the States in which the coal used in by-product coke ovens was mined have been compiled in part from returns received from the operators of these ovens and in part from data furnished by the coal operators.

Pennsylvania supplied more than 80 per cent of the coal used in the manufacture of beehive coke and nearly 33 per cent of that used in by-product ovens. About 40 per cent of the coal utilized in by-product ovens came from West Virginia, 15 per cent from Alabama, and the remainder in small quantities from five other States and from Canada.

COAL USED IN MAKING COAL GAS.

The total quantity of bituminous coal used in making coal gas for municipalities in 1915 was 4,664,795 tons, of which the place of origin of 4,563,579 tons, or 98 per cent of the total, is known and is shown in the table on page 471. Nearly 2,500,000 tons, or 55 per cent of the coal used in making gas (exclusive of that made in by-product ovens), came from Pennsylvania, the excellence of whose Westmoreland and Youghiogheny gas coals is well known. West Virginia supplied 765,000 tons, or 17 per cent, and Kentucky 617,000 tons, or 14 per cent.

COAL USED FOR DOMESTIC PURPOSES AND IN THE SMALL STEAM TRADE.

The use of coal for domestic purposes is perhaps more widespread than any other and is the use in which the greatest number of persons are directly interested. It is not possible by any means less laborious than a house to house canvass to determine the actual consumption by householders. Coal for threshing on the farm or for small engines and power plants, such as furnish electricity for towns or manufacture ice, is obtained through the same agencies as that used for domestic purposes. The supply for these uses has been classed under the general head of domestic and small-steam trade, as distinguished from the industrial steam trade, which includes the supply to such users as factories, mills, and central power stations that obtain most of their fuel directly from the producing company or from its agents or brokers. A further distinction, and an important one, is in the kinds of coal used in the two trades. The domestic trade prefers screened or lump coal; the industrial user selects the finer sizes, slack, or perhaps run-of-mine, because of its relative cheapness.

As already stated, the distinction between these two classes of uses is not fixed, and the statistics in the table on page 472 are in reality the summation of the figures and estimates made by the producers and distributors. They are, however, the best statistics of this nature that it is practicable to collect, and as they represent data furnished by a thousand or more distributors of coal, it may be assumed that the general law of averages has operated to make the totals fairly correct.

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The statistics in the table on page 472 show that 71,300,000 net tons, or 16 per cent of the consumption of bituminous coal in the United States in 1915, was consumed for domestic and similar uses. Of that quantity Illinois supplied 17,200,000 tons, or about 25 per cent, West Virginia and Virginia 13,200,000 tons, or 19 per cent, and Pennsylvania 9,400,000 tons, or 13 per cent. The preponderance of coal from Illinois in this market is due to the fact that in the East, where Pennsylvania and West Virginia soft coals would normally be used for domestic purposes, Pennsylvania anthracite is available and takes the place of bituminous coals for those purposes. In the large cities of the Middle West, however, which have strict smoke ordinances, the "smokeless" coals of West Virginia are generally used for the larger heating and the smaller steam plants. Statistics collected and published by the Committee on Smoke Abatement in Chicago[1] show that in 1912 out of a total of 4,646,910 tons of coal and coke used in low-pressure steam and other stationary heating plants—a class similar to that including the domestic and small-steam trade used in this report—1,771,272 tons, or 38 per cent, was anthracite, 889,728 tons, or 19 per cent, was West Virginia "smokeless" coal, and 1,930,833 tons, or 42 per cent, was bituminous coal from Illinois and Indiana, whereas in the high-pressure steam stationary power and heating plants 97 per cent of the fuel consumed was bituminous coal of the lower grades.

COAL USED FOR GENERAL INDUSTRIAL PURPOSES.

The coal used in all large mills, factories, power houses, and pumping plants, for burning brick and cement, and for all other purposes not otherwise stated in the table on page 472, is shown under the heading used above. The total quantity, 143,800,000 net tons, was 33 per cent of the total consumption in 1915, was twice the quantity used in the domestic and small steam trade, and was 21,000,000 tons, or one-sixth, more than was used by the railroads.

Pennsylvania supplied 37 per cent of the total, West Virginia and Virginia 23 per cent, Illinois 15 per cent, and Ohio 6 per cent. One-third of the output of Pennsylvania, 38 per cent of the output of West Virginia and Virginia, and 36 per cent of the production in Illinois was used for industrial purposes.

COAL EXPORTED.

The exports of bituminous coal from the United States in 1915 were more than 18,700,000 net tons, which was 4 per cent of the production in that year. No attempt has been made to obtain statistics showing the purposes for which this exported coal was used, but it is known that it was used mainly for railroad and steamship fuel, gas making, and steam raising. The bituminous coal exported to Egypt and Canada was used largely for railroad fuel, select lots of lump coal were shipped to South America for making gas, and a large part of that sold in Italy and other European countries was used by railroads and in steam raising. The statistics of exports are given in greater detail on pages 465–468.

[1] Smoke abatement and electrification of railway terminals in Chicago, p. 125, 1915.

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COAL USED AT THE COAL MINES FOR STEAM AND HEAT.

About 2 per cent of the bituminous coal mined in 1915 was used for generating steam and heat at the mines. This coal was consumed within the State in which it was mined and represents that part of the production which does not enter the market. With the increase in the use of electric power supplied from central stations this quantity will tend to decrease.

COAL USED FOR SPECIAL PURPOSES.

Coal used for blacksmithing and for manufacturing such products as foundry facings is included under the heading given above. The total quantity so reported is small, 714,000 net tons, about 0.1 per cent of the total production.

CONSUMPTION OF COAL, BY LOCALITIES.

The statistics presented in the following table show the consumption of bituminous coal[1] and anthracite in 1915 by States, as compiled from the statistics of distribution shown in the preceding tables. No data are available to show the increase or decrease during the year in the stocks of coal on hand, and the figures in the table therefore fail to represent actual consumption in the period covered by the amount of the difference in stored coal. The accuracy of the figures is further limited by the incompleteness of the data on distribution discussed in the introductory paragraphs of the report.

The quantity of bituminous coal in storage in ordinary times is small, compared with the total production and consumption, but in 1915 the consumers of bituminous coal increased their stocks greatly, in anticipation of a possible protracted cessation in coal mining after April 1, 1916, when new wage agreements were to be negotiated. The quantity of bitminous coal stored in the last half of 1915 is estimated at about 5,000,000 tons, most of which was held by the railroads. Between 8,000,000 and 10,000,000 net tons of anthracite is estimated to have been put in storage by the larger producing and distributing companies in the same period.

The statistics of the consumption of coal by States exclude the coal used by railroads and that taken by ocean-going steamships and vessels on the Great Lakes. It was considered impracticable to attempt to obtain figures showing the consumption of coal by railroads within the individual States, and the bunker fuel can not properly be assigned to any particular States. The consumption of bituminous coal at the coal mines and in the manufacture of coke and coal gas is shown separately for each State, so far as the reports of individual producers would not be disclosed by their publication. The sum of these quantities was subtracted from the total consumption of bituminous coal, as shown in the tables on pages 487–492, and the result for each State was considered to represent coal used for domestic and all other industrial purposes, such as the generation of steam, production of producer gas, and cement burning. All Pennsylvania anthracite except that consumed by railroads was considered to fall within this classification.

[1] Imported coal is not included in these figures except that used for manufacturing by-product coke in New England.

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Coal of domestic origin consumed in the United States in 1915.

[Railroad fuel and bunker fuel for ocean vessels and for steamships on the Great Lakes are not included in this table.]

State.	Used at mines for steam and heat: Bituminous (net tons).	Used in manufacture of beehive coke: Bituminous (net tons).	Used in manufacture of by-product coke: Bituminous (net tons).	Used in manufacture of coal gas: Bituminous (net tons).	Used for industrial and domestic purposes.			Total coal consumed.		
					Bituminous (net tons).	Anthracite (net tons).	Bituminous and anthracite (net tons).	Bituminous (net tons).	Anthracite (net tons).	Bituminous and anthracite (net tons).
	1	2	3	4	5	6	7	8	9	10
Alabama	535,340	1,708,228	2,987,710	74,551	2,218,711	8,100	2,226,811	7,524,540	8,100	7,532,640
Arizona					158,723		158,723	158,723		158,723
Arkansas	62,175				432,980	800	433,780	495,155	800	495,955
California	[a] 300				331,672	500	332,172	331,972	500	332,472
Colorado	294,571	1,026,019		101,540	3,673,419	600	3,674,019	5,095,549	600	5,096,149
Delaware				(b)	[c] 1,206,197	210,000	1,415,693	1,206,197	210,000	1,416,197
Florida				(b)	[c] 225,176	25,000	225,575	225,176	25,000	250,176
Georgia	7,200	35,377		73,786	2,060,157	50,000	2,110,157	2,176,520	50,000	2,226,520
Idaho				6,930	343,450	200	343,650	350,380	200	350,580
Illinois	1,533,069		2,335,933	208,671	35,899,177	3,292,000	39,191,177	39,976,850	3,292,000	43,268,850
Indiana	425,352		3,685,774	150,587	11,855,052	600,000	12,455,052	16,116,765	600,000	16,716,765
Iowa	148,159			60,555	6,667,571	310,000	6,977,571	6,876,285	310,000	7,186,285
Kansas	184,071			(b)	[c] 2,978,711	25,000	3,000,206	3,162,782	25,000	3,187,782
Kentucky	495,313	462,168	337,679	14,111	3,887,050	20,000	3,907,050	5,196,321	20,000	5,216,321
Louisiana				(b)	[c] 1,477,886	15,000	1,490,386	1,477,886	15,000	1,492,886
Maryland and District of Columbia	64,588		470,326	40,045	3,309,856	1,470,000	4,779,856	3,884,815	1,470,000	5,354,815
Michigan	35,719		(b)	629,492	[d] 9,611,073	838,800	9,481,525	10,276,284	838,800	11,115,084
Minnesota			180,767	84,164	5,571,637	1,670,000	7,241,637	5,836,568	1,670,000	7,506,568
Mississippi				12,596	1,355,792	2,000	1,357,792	1,368,388	2,000	1,370,388
Missouri	84,091		(b)	383,336	[d] 7,247,821	371,300	7,452,204	7,715,248	371,300	8,086,548
Montana	122,592			8,951	2,122,168	5,000	2,127,168	2,253,711	5,000	2,258,711
Nebraska					3,188,180	527,300	3,715,480	3,188,180	527,300	3,715,480
Nevada					217,412		217,412	217,412		217,412
New England			[e] 666,930	882,395	18,962,662	13,767,000	32,729,662	20,511,987	13,767,000	34,278,987
New Jersey			(b)	99,862	[d] 4,068,955	8,375,000	12,093,979	4,168,817	8,375,000	12,543,817
New Mexico	28,868	732,830		(b)	[c] 317,767		316,062	1,079,465		1,079,465
New York			975,656	828,933	15,381,602	20,789,494	36,171,096	17,186,191	20,789,494	37,975,685
North and South Carolina				40,494	2,617,683	124,000	2,741,683	2,658,177	124,000	2,782,177
North Dakota	17,499			(b)	[c] 1,323,385	360,000	1,667,329	1,340,884	360,000	1,700,884
Ohio	465,701	28,815	956,656	95,572	20,821,292	600,000	21,421,292	22,368,036	600,000	22,968,036
Oklahoma	247,565			6,048	754,898	500	755,398	1,008,511	500	1,009,011
Oregon	6,817			3,387	332,559	200	332,759	342,763	200	342,963

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Pennsylvania	13,045,069	33,972,018	4,301,726	231,160	13,901,084	23,292,534	37,283,618	65,540,907	23,292,584	88,833,551
South Dakota				(b)	c 1,014,683	180,000	1,192,269	1,014,683	180,000	1,194,683
Tennessee	167,560	433,731	32,064	62,162	2,864,051	9,000	2,873,051	3,559,638	9,000	3,568,638
Texas	89,356			(b)	c 2,074,466	22,000	2,096,984	2,163,822	22,000	2,185,822
Utah	104,304	(b)		35,002	1,839,396		1,180,009	1,978,702		1,978,702
Virginia	138,799	995,896		90,801	3,064,838	170,000	3,224,838	4,286,834	170,000	4,456,834
Washington	120,047	(b)	(b)	119,488	d 840,299	1,900	657,320	1,065,784	1,900	1,067,684
West Virginia	1,141,178	2,071,001	202,763	(b)	c 2,752,288	35,000	2,815,506	6,197,229	35,000	6,232,229
Wisconsin			(b)	237,288	d 7,414,981	1,730,000	8,256,226	7,652,249	1,730,000	9,382,249
Wyoming	256,932			(b)	c 373,648	200	372,168	630,580	200	630,780
	19,785,225	42,278,516	19,554,352	4,644,566	203,584,367	78,898,478	232,482,945	289,357,066	78,898,478	368,755,534

a Includes small quantities used at coal mines in Idaho and Nevada.
b Included with column 5.
c Includes coal used in manufacture of coal gas.
d Includes coal used in manufacture of by-product coke.
e Includes coal imported from Canada.

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Coal of domestic origin consumed in the United States—Continued.

State.	Population.[a]	Average consumption per capita of coal used for industrial and domestic purposes.			Value of manufactured products.[b]	Area (square miles).	Consumption of all coal per square mile (net tons.)[c]
		Bituminous (net tons).	Anthracite (net tons).	Bituminous and anthracite (net tons).			
	11	12	13	14	15	16	17
Alabama	2,301,277	0.96	(d)	0.96	$175,897,000	51,998	145
Arizona	247,299	.64	.....	.64	24,805,000	113,956	1
Arkansas	1,713,102	.25	(d)	.25	83,941,000	53,335	9
California	2,848,275	.12	(d)	.11	712,801,000	158,297	2
Colorado	935,799	3.92	(d)	3.92	136,839,000	103,948	49
Delaware	211,598	5.70	0.99	6.69	56,042,000	2,370	597
Florida	870,802	.23	.03	.26	81,112,000	58,666	4
Georgia	2,816,289	.73	.02	.75	253,320,000	59,265	37
Idaho	411,996	.83	(d)	.83	28,454,000	84,313	4
Illinois	6,089,519	5.91	.54	6.45	2,247,323,000	56,665	764
Indiana	2,798,142	4.24	.21	4.45	730,795,000	36,354	460
Iowa	2,358,066	2.83	.13	2.96	310,954,000	56,147	128
Kansas	1,807,221	1.65	.01	1.66	323,234,000	82,158	39
Kentucky	2,365,185	1.64	.01	1.65	230,249,000	40,598	128
Louisiana	1,801,306	.82	.01	.83	255,507,000	48,506	31
Maryland and District of Columbia	1,710,620	1.93	.86	2.79	406,668,000	12,397	432
Michigan	3,015,442	2.87	.28	3.14	1,086,162,000	57,980	192
Minnesota	2,246,761	2.48	.74	3.22	493,354,000	84,682	89
Mississippi	1,926,778	.70	(d)	.70	79,550,000	46,865	29
Missouri	3,391,789	2.09	.11	2.20	637,952,000	69,420	116
Montana	446,064	4.76	.01	4.77	84,446,000	146,572	15
Nebraska	1,258,624	2.53	.42	2.95	221,616,000	77,520	48
Nevada	102,730	2.12	.....	2.12	16,063,000	110,690	2
New England	7,059,361	2.69	1.95	4.64	2,924,218,000	66,424	516
New Jersey	2,881,840	1.29	2.90	4.19	1,406,633,000	8,224	1,525
New Mexico	396,917	.80	.....	.80	9,320,000	122,634	9
New York	10,086,568	1.52	2.06	3.58	3,814,661,000	49,204	772
North and South Carolina	3,978,841	.66	.03	.69	425,303,000	83,415	33
North Dakota	713,063	1.83	.50	2.33	21,147,000	70,837	24
Ohio	5,088,627	4.09	.12	4.21	1,782,808,000	41,040	560
Oklahoma	2,114,307	.35	(d)	.36	102,006,000	70,057	14
Oregon	809,490	.41	(d)	.41	109,762,000	96,699	3
Pennsylvania	8,383,992	1.67	2.78	4.45	2,832,349,000	45,126	1,968
South Dakota	690,046	1.49	.26	1.75	24,139,000	77,615	15

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Tennessee	2,271,379	1.26	(d)	1.26	212,071,000	42,022	85
Texas	4,343,710	.48	(d)	.48	361,279,000	265,896	8
Utah	424,300	2.79	.....	2.79	87,114,000	84,990	23
Virginia	2,171,014	1.41	(d)	1.41	264,039,000	42,627	104
Washington	1,471,043	.43	(d)	.43	245,327,000	69,127	16
West Virginia	1,359,474	2.04	(d)	2.04	193,512,000	24,170	258
Wisconsin	2,473,533	2.64	.70	3.34	695,172,000	56,066	167
Wyoming	174,148	2.14	(d)	2.14	11,223,000	97,914	6
	100,536,347	2.04	.78	2.82	24,202,187,000	3,026,789	123

NOTE.—The averages and other figures are derived as shown below, the numbers corresponding to those over the columns of figures in the table:
5= 8−(1+2+3+4).
6= 9.
7= 5+ 6.
10= 8+ 9.
12= 5+11.
13= 6+11.
14=12+13 or 7+11.
17=10+16.

a Estimate by the Bureau of the Census of population on July 1, 1915.
b Census of 1914.
c Included all anthracite and bituminous coal, except that used by railroads and for bunkering vessels.
d Less than 0.01 ton.

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CONSUMPTION OF COAL PER CAPITA.

The consumption of coal is a measure of the industrial activity of a people, for as yet coal is the main source of mechanical energy. In this respect the United States is the foremost nation, its average annual consumption of coal for all purposes being about 5 tons per capita. According to the estimates of J. R. Finlay,[1] prior to the present war in Europe the consumption of coal per capita in England, Belgium, and Germany was about 4 tons, in Russia a quarter of a ton, and in France about 1.6 tons. In Finlay's opinion, these comparative figures do not necessarily mean that specialized industries are not fully as well developed, for instance, in France, as in the United States, but rather that mass energy is much less in France, where most of the people work on farms or in shops and work more with their hands and less with machinery than in the United States. The consumption of coal in the United States in 1915, ascertained by subtracting from the sum of the production and imports of bituminous coal and anthracite the exports and foreign bunker fuel, was 502,220,104 net tons, or almost exactly 5 tons per capita. The figures showing the consumption per capita in the foregoing table represent the total bituminous coal and anthracite used for domestic and industrial or manufacturing purposes exclusive of that used by the railroads and by ocean and Lake steamships, that used at the coal mines for generating steam and heat, and that used for making coke and coal gas.

The quantity of fuel used per capita for domestic and industrial purposes, as thus defined, is then a function of climate and industrial activity. It is also affected by the competition of other fuels, as petroleum and natural gas, and of hydroelectric energy.

All the States except Tennessee south of a line connecting the southern borders of Virginia and Utah and the Pacific coast States, California, Oregon, Washington, and Idaho, consume less than 1 ton of coal per capita. These States, in which the per capita consumption ranges from 0.12 ton in California to 0.96 ton in Alabama, include the most productive oil fields in the United States, and their small use of coal is doubtless in part due to the use of petroleum, although no large use of fuel is to be expected in these States because of the general warmth of the climate and the comparative lack of manufacturing industries. The per capita consumption of coal in Colorado (3.92 tons) and Montana (4.77 tons) is well above the average for the mountain States, largely because of their metal industries and the comparatively greater average abilitv of their people who are engaged in those industries to buy coal.

The averages for the States bordering Mississippi River afford an excellent example of the influence of climate and manufacturing activity in coal consumption. The per capita consumption of Louisiana in 1915 was 0.83 ton, and of Mississippi 0.71 ton. Arkansas, with manufactures valued at one-fourth those of Louisiana, used about one-fourth of the coal per capita, and Tennessee, with manufactures of about equal value to those of Louisiana, used 50 per cent more coal. Missouri, where the climate is somewhat colder, used 2.2 tons per capita. Iowa, farther north, used 2.96 tons, and

[1] Min. and Met. Soc. America Bull. 86, vol. 8, No. 7, p. 151, 1915.

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Minnesota and Wisconsin, still farther north, used 3.22 and 3.34 tons, respectively. The greater manufacturing industries centering about Chicago raised the average for Illinois to 6.45 tons and for Indiana to 4.45 tons, both figures higher than for any adjoining States, Ohio, the next largest consumer, using 4.21 tons. As indicative of the comparative accuracy of these figures, it may be noted that the detailed investigation of the Committee on Smoke Abatement[1] showed for 1912 a per capita consumption of coal and coke in the Chicago district alone of 8.3 tons.

Along the Atlantic seaboard the average is lowest in Florida (0.23 ton) and highest in Delaware (6.69 tons), although the general average increases from south to north and exclusive of Delaware is greatest (4.64 tons) in the New England States, where exigencies of climate and intensity of manufacturing cause a large demand for fuel.

In a general way the average consumption of coal increases from south to north because of climate and from west to east in proportion to increase in manufacturing activity. The area of largest consumption lies in a belt extending from Chicago east to New York and Philadelphia and north along the coast to and including New England. If the statistics of consumption of coke by States[2] are included with those of coal, the influence of the iron-making industry on the consumption of coal is more clearly shown. The more or less uniform increase in per capita consumption of coal from south to north and west to east is broken by three local high points—in Colorado, at Chicago, and in western Pennsylvania, all centers of iron and steel manufacture. The use of coke in the Birmingham iron district of Alabama raised the average from less than 1 ton for coal alone, as given in the preceding table, to more than 3 tons for coal and coke together.

CONSUMPTION OF COAL PER SQUARE MILE.

The density of the consumption of coal is indicated by the consumption per square mile, and is a function of per capita consumption of coal, density of population, and intensity of industrial activity. In other words, the density of consumption will be least in sparsely settled States, in the warmer climates, and where manufacturing is poorly developed, and greatest where the population is densest, the climate is coldest, and the manufacuring industries are the most concentrated. The extremes in the United States are found in Arizona, which consumes 1 ton per square mile of area, and Pennsylvania, which consumes 1,968 tons per square mile.

The averages shown in the table on page 482 were obtained by dividing the total quantity of bituminous coal and anthracite consumed, excluding only railroad and bunker fuel, by the area in square miles of each State or group of States. In much the same manner as the averages of the consumption of coal per capita, the averages per square mile exhibit an increase from south to north and from west to east, with the important difference, however, that in the belt extending across the center of the country, from Utah and Colorado

[1] Smoke abatement and electrification of railway terminals in Chicago, p. 127, Chicago, 1915.
[2] See current report on coke, U. S. Geol. Survey Mineral Resources, 1915, pt. 2, pp. 515–558, 1916.

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through Illinois, Indiana, Ohio, and Pennsylvania to the Atlantic, the average for each State is above those for the States lying to the north and south, and in general above those for the States to the west. Thus the average for Colorado is 49 tons per square mile, for Wyoming 6 tons, for Utah 23 tons, and for New Mexico 9 tons. The average for Iowa is 128 tons per square mile, for Minnesota 89 tons, for Nebraska 48 tons, and for Missouri 116 tons. The average for Pennsylvania is 1,968 tons per square mile, for New York 772 tons, for Ohio 560 tons, and for Maryland 591 tons. That is, the third factor introduced, density of population, has in this belt partly offset the other two factors, which govern consumption per capita—climate and intensity of manufacturing. The maximum average consumption of coal per square mile follows a line extending approximately from Salt Lake City through Denver, Omaha, Chicago, Youngstown, Ohio, and New York City. The report of the Committee on Smoke Abatement, already cited, shows an average of 387,167 tons of coal and coke consumed per square mile in the "loop" district of Chicago in 1912, and 49,528 tons per square mile for the Chicago district.

RELATION OF CONSUMPTION OF COAL TO VALUE OF MANUFACTURES.

Coal is the principal source of energy in the processes of manufacturing, and the quantity so used bears a certain relation to the value of the manufactured products. The relation can be studied properly, however, only by considering simply the value of the products in making which coal was used for power, or, if the value of all the manufactured products is considered, by adding to the coal used in any locality the equivalent in terms of coal of whatever fuel oil, natural gas, or water power may have been used in that locality. Neither has been done in this report. In the following table are shown the average consumption of coal—for all purposes other than railroad and steamship fuel—and the value of manufactured products (according to the census of 1914) per 1,000 tons of coal consumed, by major geographic subdivisions.

It will be noted that the value of the manufactured products per 1,000 tons of coal consumed is greater in New England than in any other area except the west south central and Pacific coast regions. The reason for this is obvious; in these two regions fuel oil is used almost to the exclusion of coal in manufacturing plants, and the average obtained by dividing the total value of manufactures by the quantity of coal used is correspondingly high. The per capita consumption of coal in New England is nearly 14 times as great as on the Pacific coast and more than 9 times as great as in the southern States west of Mississippi River.

The ratio of value of manufactured products to coal used depends, of course, on the character of the product manufactured. The ratio is low if the product is coke and high if the product is shoes or watches. The census figures include the manufacture of coke, and for that reason the ratio in the middle Atlantic region, which embraces the coking districts of Pennsylvania, is lower than that for New England or that for the joining areas on the west and south.

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Ratio of coal consumed in the United States to population and to value of manufactured products.

Geographic division.[a]	Consumption per capita of all coal (net tons).[b]	Value of manufactured products for each 1,000 tons of coal consumed.[b]
New England States	4.85	$85,000
Middle Atlantic States	6.52	58,000
South Atlantic States	1.72	74,000
East North Central States	5.31	63,000
West North Central States	2.61	63,000
East South Central States	2.00	39,000
West South Central States	.52	156,000
Mountain States	3.76	33,338
Pacific Coast States	.35	605,728

[a] New England division: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut. Middle Atlantic division: New York, New Jersey, Pennsylvania. East North Central division: Ohio, Indiana, Illinois, Michigan, Wisconsin. West North Central division: Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas. South Atlantc division: Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida. East South Central division: Kentucky, Tennessee, Alabama, Mississippi. West South Central division: Arkansas, Louisiana, Oklahoma, Texas. Mountain division: Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada. Pacific division: Washington, Oregon, California.

[b] Ratios determined on the basis of all coal consumed except that used for fuel by railroads and steamships.

CONSUMPTION OF COAL, BY STATES, ACCORDING TO SOURCE.

The data in the following tables were compiled from the tables showing distribution of the coal from the States that produce coal (pp. 447–464), distribution of Lake shipments (p. 442), and distribution of tidewater shipments (p. 441). The following tables show the quantity of coal shipped into each State for consumption and the quantity produced within the State and furnish an idea of the extent to which the different producing districts share in the various markets.

Coal consumed in different States, 1915, in net tons.

[Exclusive of fuel for railroads and steamships.]

Alabama.

Source.	Quantity.
Alabama	7,347,886
Georgia	38
Kentucky	56,913
Tennessee	48,942
Virginia	67,961
West Virginia	2,800
Total bituminous coal	7,524,540
Pennsylvania anthracite	8,100
	7,532,640

Arizona.

New Mexico	158,273
West Virginia	450
	158,723

Arkansas.

Source.	Quantity.
Alabama	10,450
Arkansas	233,386
Colorado	14,234
Georgia	73
Illinois	128,950
Kansas	13,669
Kentucky	86,966
Missouri	[a] 1,888
Oklahoma	453
Pennsylvania	86
Total bituminous coal	495,155
Pennsylvania anthracite	800
	495,955

[a] Includes Missouri coal consumed in Illinois.

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Coal consumed in different States, 1915, in net tons—Continued.

California.

Source.	Quantity.
Alabama	292
California	[a] 12,503
Colorado	5,771
Georgia	30
Maryland	[b] 10,244
New Mexico	75,025
Pennsylvania	5,324
Utah	161,987
West Virginia	17,250
Wyoming	43,546
Total bituminous coal of domestic origin	331,972
Imports	284,225
	616,197
Approximate quantity supplied vessels for bunker fuel	170,000
Approximate consumption of bituminous coal on land	446,197
Pennsylvania anthracite	500
	446,697

Colorado.

Colorado	4,987,475
New Mexico	107,877
Pennsylvania	96
Wyoming	101
Total bituminous coal	5,095,549
Pennsylvania anthracite	600
	5,096,149

Delaware.

Maryland	9,327
Pennsylvania	951,419
West Virginia	245,451
Total bituminous coal	1,206,197
Pennsylvania anthracite	210,000
	1,416,197

District of Columbia and Maryland.

Maryland	852,169
Pennsylvania	1,514,354
Virginia	3,913
West Virginia	814,379
Maryland, Pennsylvania, and West Virginia	[c] 700,000
Total bituminous coal	3,884,815
Pennsylvania anthracite	1,470,000
	5,354,815

Florida.

Source.	Quantity.
Alabama	108,782
Georgia	30
Kentucky	17,268
Tennessee	26,886
Virginia	40,230
West Virginia	31,980
Total bituminous coal	225,176
Pennsylvania anthracite	25,000
	250,176

Georgia.

Alabama	363,572
Georgia	120,772
Kentucky	800,822
Tennessee	481,271
Virginia	368,751
West Virginia	41,382
Total bituminous coal	2,176,520
Pennsylvania anthracite	50,000
	2,226,520

Idaho.

Idaho	[d]
Montana	9,311
Pennsylvania	33
Utah	227,417
Washington	25,000
Wyoming	87,619
Lake coal	1,000
Total bituminous coal	350,380
Pennsylvania anthracite	200
	350,580

Illinois.

Illinois	26,781,713
Indiana	4,044,528
Iowa	17,700
Kentucky	864,047
Maryland	20,783
Missouri	[e]
Ohio	287,561
Pennsylvania	1,677,186
Virginia	120,300
West Virginia	5,079,032
Lake coal	1,084,000
Total bituminous coal	39,976,850
Pennsylvania anthracite	3,292,000
	43,268,850

[a] Includes coal produced in Idaho and Nevada and consumed within those States.
[b] Includes Maryland coal consumed in the State of Washington.
[c] Tidewater coal dumped at Baltimore and used in Chesapeake Bay. Quantity only approximate.
[d] Included with coal produced in California and Nevada and consumed within the three States; see table of California consumption.
[e] Included with Missouri coal consumed in Arkansas.

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Coal consumed in different States, 1915, in net tons—Continued.

Indiana.

Source.	Quantity.
Illinois	826,601
Indiana	6,394,019
Kentucky	2,886,806
Maryland	6,947
Ohio	350,251
Pennsylvania	855,259
Tennessee	22,590
Virginia	152,291
West Virginia	4,072,001
Lake coal	551,000
Total bituminous coal	16,116,765
Pennsylvania anthracite	600,000
	16,716,765

Iowa.

Arkansas	16,537
Colorado	12,660
Illinois	3,053,413
Indiana	149,046
Iowa	2,786,570
Kentucky	335,431
Maryland	[a] 5,898
Missouri	22,729
Ohio	1,666
Pennsylvania	66,973
Virginia	1,500
West Virginia	159,444
Wyoming	16,418
Lake Coal	248,000
Total bituminous coal	6,876,285
Pennsylvania anthracite	310,000
	7,186,285

Kansas.

Arkansas	114,812
Colorado	340,779
Illinois	414,467
Indiana	149
Iowa	40,092
Kansas	1,879,725
Kentucky	54,871
Missouri	167,483
New Mexico	98,103
Oklahoma	12,038
Pennsylvania	1,333
West Virginia	390
Wyoming	38,540
Total bituminous coal	3,162,782
Pennsylvania anthracite	25,000
	3,187,782

Kentucky.

Illinois	6,807
Kentucky	4,429,055
Maryland	[b]
Ohio	[c] 371
Pennsylvania	131,101
Tennessee	185,580
West Virginia	443,407
Total bituminous coal	5,196,321
Pennsylvania anthracite	20,000
	5,216,321

Louisiana.

Source.	Quantity.
Alabama	717,437
Arkansas	93
Illinois	67,338
Kentucky	215,007
Pennsylvania	478,011
Total bituminous coal	1,477,886
Pennsylvania anthracite	15,000
	1,492,886

Michigan.

Illinois	83,256
Indiana	6,088
Kentucky	1,061,640
Maryland	48,124
Michigan	761,217
Ohio	1,453,869
Pennsylvania	1,948,235
Tennessee	240
Virginia	29,205
West Virginia	4,326,412
Lake coal	558,000
Total bituminous coal	10,276,284
Pennsylvania anthracite	838,800
	11,115,084

Minnesota.

Arkansas	5,372
Illinois	1,334,330
Indiana	72,934
Iowa	12,557
Kentucky	345,333
Ohio	65,094
Pennsylvania	120,244
Virginia	47,000
West Virginia	40,704
Lake coal	3,793,000
Total bituminous coal	5,836,568
Pennsylvania anthracite	1,670,000
	7,506,568

Mississippi.

Alabama	596,218
Illinois	96,577
Kentucky	630,518
Pennsylvania	45,075
Total bituminous coal	1,368,388
Pennsylvania anthracite	2,000
	1,370,388

Missouri.

Alabama	3,519
Arkansas	198,768
Colorado	535
Georgia	538
Illinois	4,391,722
Indiana	12,632
Iowa	174,164
Kansas	926,480
Kentucky	478,164
Maryland	[d] 9,090
Missouri	1,059,416

[a] Includes Maryland coal consumed in Kentucky.
[b] Included with Maryland coal consumed in Iowa.
[c] Includes Ohio coal consumed in South Dakota.
[d] Includes Maryland coal consumed in Texas.

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Coal consumed in different States, 1915, in net tons—Continued.

Missouri—Continued.

Source.	Quantity.
Oklahoma	3,653
Pennsylvania	294,820
Virginia	1,500
West Virginia	158,763
Wyoming	1,484
Total bituminous coal	7,715,248
Pennsylvania anthracite	371,300
	8,086,548

Montana.

Maryland	58
Montana	1,638,750
Utah	17,301
Wyoming	594,602
Lake coal	3,000
Total bituminous coal	2,253,711
Pennsylvania anthracite	5,000
	2,258,711

Nebraska.

Arkansas	120,376
Colorado	422,320
Illinois	938,905
Indiana	2,833
Iowa	143,108
Kansas	774,937
Kentucky	92,091
Missouri	203,337
New Mexico	339
Pennsylvania	24,963
West Virginia	1,553
Wyoming	363,418
Lake coal	100,000
Total bituminous coal	3,188,180
Pennsylvania anthracite	527,300
	3,715,480

Nevada.

Colorado	[a] 2,526
Nevada	(b)
New Mexico	135
Utah	169,928
West Virginia	300
Wyoming	44,523
	217,412

New England.

Maryland	630,097
Pennsylvania	6,587,890
West Virginia	20,419
Received via tidewater	13,273,581
Total bituminous coal	20,511,987
Pennsylvania anthracite	13,767,000
	34,278,987

New Jersey.

Source.	Quantity.
Maryland	33,561
Pennsylvania	3,489,656
West Virginia	645,600
Total bituminous coal	4,168,817
Pennsylvania anthracite	8,375,000
	12,543,817

New Mexico.

Colorado	22,948
New Mexico	1,056,438
Pennsylvania	29
West Virginia	50
	1,079,465

New York.

Maryland	[c] 567,421
Ohio	115,221
Pennsylvania	14,430,879
West Virginia	2,072,670
Total bituminous coal	17,186,191
Pennsylvania anthracite	20,789,494
	37,975,685

North and South Carolina.

Alabama	475
Georgia	500
Kentucky	143,660
Pennsylvania	305
Tennessee	168,512
Virginia	1,366,943
West Virginia	977,782
Total bituminous coal	2,658,177
Pennsylvania anthracite	124,000
	2,782,177

North Dakota.

Illinois	106,674
Indiana	3,255
Kentucky	418
Montana	44,814
North Dakota	519,969
Pennsylvania	380
Virginia	15,391
West Virginia	425
Wyoming	96,558
Lake coal	553,000
Total bituminous coal	1,340,884
Pennsylvania anthracite	360,000
	1,700,884

[a] Includes Colorado coal consumed in Utah.
[b] Included with coal produced in California and Idaho and consumed in the States of California, Idaho, and Nevada. See California table.
[c] Includes small quantity of Maryland coal exported by rail to Canada.

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Coal consumed in different States, 1915, in net tons—Continued.

Ohio.

Source.	Quantity.
Illinois	3,036
Kentucky	1,359,813
Maryland	37,305
Ohio	9,663,496
Pennsylvania	7,197,013
Tennessee	23,974
Virginia	169,432
West Virginia	5,375,560
	23,829,629
Bunker fuel for vessels on Lake Erie	1,461,593
Consumption of bituminous coal on land	22,368,036
Pennsylvania anthracite	300,000
	22,668,036

Oklahoma.

Alabama	713
Arkansas	60,791
Colorado	120,298
Kansas	75,162
Missouri	4,800
New Mexico	24,096
Oklahoma	722,555
Pennsylvania	96
Total bituminous	1,008,511
Pennsylvania anthracite	500
	1,009,011

Oregon.

Alabama	190
Oregon	32,315
Pennsylvania	126
Utah	30,755
Washington	172,090
Wyoming	106,787
Lake coal	500
Total bituminous coal	342,763
Pennsylvania anthracite	200
	342,963

Pennsylvania.

Kentucky	[a] 79,125
Maryland	505,860
Ohio	17,075
Pennsylvania	59,993,642
West Virginia	4,945,295
Total bituminous coal	65,540,997
Pennsylvania anthracite	23,292,584
	88,833,581

South Dakota.

Colorado	12,598
Illinois	319,370

South Dakota—Continued.

Source.	Quantity.
Indiana	3,897
Iowa	24,120
Kentucky	89,220
Montana	25,702
North Dakota	5,000
Ohio	[b]
South Dakota	10,503
Virginia	4,000
West Virginia	10,833
Wyoming	152,350
Lake coal	357,000
Total bituminous coal	1,014,683
Pennsylvania anthracite	180,000
	1,194,683

Tennessee.

Alabama	161,754
Arkansas	15,258
Georgia	7,359
Illinois	68,559
Indiana	33
Kentucky	1,560,776
Pennsylvania	30,613
Tennessee	1,340,737
Virginia	373,244
West Virginia	1,305
Total bituminous coal	3,559,638
Pennsylvania anthracite	9,000
	3,568,638

Texas.

Alabama	39,987
Arkansas	78,418
Colorado	[c] 273,337
Georgia	156
Illinois	20,648
Kentucky	40,112
Maryland	[d]
New Mexico	313,589
Oklahoma	381,131
Pennsylvania	239
Tennessee	56,168
Texas	873,456
Virginia	54,300
West Virginia	2,281
Total bituminous coal	2,133,822
Pennsylvania anthracite	22,000
	2,155,822

Utah.

Colorado	[e]
Utah	1,903,749
West Virginia	165
Wyoming	74,788
	1,978,702

[a] Includes coal from Kentucky exported by rail to Canada.
[b] Included with Ohio coal consumed in Kentucky.
[c] Includes Colorado coal exported to Mexico.
[d] Included with Maryland coal consumed in Missouri.
[e] Included with Colorado coal consumed in Nevada.

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Coal consumed in different States, 1915, in net tons—Continued.

Virginia.

Source.	Quantity.
Alabama	307
Kentucky	2,064
Maryland	787
Pennsylvania	51,064
Virginia	2,004,314
West Virginia	2,228,268
Total bituminous coal	4,286,834
Pennsylvania anthracite	170,000
	4,456,834

Washington.

Alabama	21
Maryland	(a)
Montana	20,859
Utah	32,039
Washington	932,488
Wyoming	100,277
Lake coal	100
Total bituminous coal	1,085,784
Pennsylvania anthracite	1,900
	1,087,684

West Virginia.

Kentucky	87
Maryland	6,525
Ohio	15,500
Pennsylvania	175,000
West Virginia	6,000,117
Total bituminous coal	6,197,229
Pennsylvania anthracite	35,000
	6,232,229

Wisconsin.

Illinois	1,260,188
Indiana	128,190
Kentucky	379,644
Ohio	10,428
Pennsylvania	142,694
Virginia	9,000
West Virginia	839,105
Lake coal	4,883,000
Total bituminous coal	7,652,249
Pennsylvania anthracite	1,730,000
	9,382,249

Wyoming.

Colorado	20,984
Utah	50
Wyoming	609,546
Total bituminous coal	630,580
Pennsylvania anthracite	200
	630,780

a Included with Maryland coal consumed in California.

REVIEWS OF THE COAL TRADE IN 1915 IN SOME OF THE PRINCIPAL CITIES, WITH STATISTICS OF CONSUMPTION AND MOVEMENT.

BALTIMORE.

By SAMUEL G. WILMER, financial editor of The Manufacturers' Record.

The most important feature of the coal trade at Baltimore in 1915 was the large increase in exports of bituminous coal caused by the war in Europe. All records of the port for shipments of coal were broken, for the exports were more than double those of 1914, and during the summer the monthly exports were two and one-half to four times as large as they were in the corresponding months of 1914. A large part of this coal went to Italy and a considerable quantity to Egypt. The increase in exports in 1915 was more than 102 per cent, but there was little increase in coastwise shipments.

In the earlier months of the year the market for bituminous coal was very dull—the increase in exports did not begin until April—but when the active demand from abroad began prices soon doubled and the trade was strongly stimulated. The foreign demand, which continued to be heavy through the summer and early autumn, imparted vigor to the trade and caused a large output from the mines, which the market absorbed as fast as it came. Labor conditions

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afterward affected production and consequently the price of coal. The manufactories of war munitions offered higher wages than the coal mines, so that the mines soon were short of labor, and the shortage quickly had the effect of increasing contract prices for coal.

The market for anthracite in Baltimore was also dull in the first half of the year. The winter was mild, and much less coal than usual was burned for heating dwellings, that being the principal use for hard coal in this city. The consumption of anthracite generally declines in a mild winter, for many poor families economize by cutting down their expenditures for fuel, some of them perhaps using wood, which, while old buildings are being wrecked where improvements are in progress, may sometimes be obtained for little or nothing. This economy has a considerable effect on the demand for coal, which is, moreover, lessened by any increase in price. During the last six months of the year the trade in anthracite was normal. There is, however, a constant increase in the use of gas for cooking, which has greatly decreased the demand for the smaller sizes of hard coal, and the effect of this use is especially apparent in summer, when there is almost no demand for range coal, which formerly was used all the year round.

It is expected in the trade that the recent liberal concessions made in adjustments between the miners and operators, resulting in a considerable increase in the price of anthracite, will have an unfavorable effect on the demand for this coal and will turn attention to other fuels and hasten the adoption of gas for heating, preparation for the general introduction of which is being made by the local public service company, which provides both gas and electricity. It is also possible that natural gas will be piped to Baltimore from fields in West Virginia, and if it is so piped the use of this gas will destroy the local trade of the dealers in anthracite. Yet the people of Baltimore are conservative, and the introduction of gas for heating may be comparatively slow, notwithstanding that its use for cooking has grown and is growing rapidly. The quantity of anthracite used in Baltimore in 1915, as shown by deducting the total shipments from the total receipts, was about 662,540 net tons, although some of this perhaps was sent by rail for consumption to places near Baltimore. The quantity of bituminous coal apparently consumed locally was 707,218 net tons, but this was also probably reduced by shipments to neighboring places. The quantity of coke used in the city was 56,417 net tons.

Receipts and shipments of coal and coke at Baltimore, Md., 1914–15, in net tons.

Kind.	1914			1915		
	Receipts.	Tidewater shipments.		Receipts.	Tidewater shipments.	
		Coastwise.[a]	Export.		Coastwise.[a]	Export.
Coal:						
Bituminous	5,708,646	3,627,559	1,053,591	6,749,336	3,912,476	2,129,642
Anthracite	1,019,461	322,064	5,154	907,761	241,689	3,532
	6,728,107	3,949,623	1,058,745	7,657,097	4,154,165	2,133,174
Coke	244,935	.....	20,540	95,943	.....	39,526

[a] Includes foreign and domestic bunker coal and that used in Baltimore Harbor and Chesapeake Bay.

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Distribution of bituminous coal received at Baltimore, Md., in 1915.

	Net tons.
Foreign cargo	2,129,642
Foreign bunker	653,664
Coastwise cargo	1,873,552
Coastwise bunker	232,732
Baltimore Harbor and Chesapeake Bay	1,152,528
Dumped over piers	6,042,118
Used locally	707,218
	6,749,336

The extraordinary expansion of exports of bituminous coal last year is displayed in the table below, which shows the total tonnage shipped abroad each month:

Bituminous coal and coke exported from Baltimore in 1915, in net tons.

Month and year.	Coal.	Coke.	Month and year.	Coal.	Coke.
1915.			1915.		
January	100,553	748	December	78,328	26
February	88,512	0			
March	86,115	0		2,129,642	39,526
April	216,488	468	1914		
May	260,810	444	1913	1,053,591	23,005
June	342,627	8,971	1912	975,129	70,982
July	289,615	13,521	1911	703,945	61,168
August	236,051	6,468	1910	536,588	110,079
September	225,037	233	1909	552,626	52,469
October	156,410	8,197	1908	371,858	56,499
November	49,096	450		389,188	117,955

Thanks are due to the Baltimore & Ohio, the Pennsylvania, and the Western Maryland railroad companies for courteously furnishing the statistics for this review.

BOSTON.

By ROBERT S. COFFIN, secretary of the committee on fuel supply, Boston Chamber of Commerce.

The coal situation in Boston in 1915 was abnormal, owing in large measure to the European war. The abnormal condition was particularly noticeable in coastwise freights, as sailing vessels and steamers were able to charter for off-shore business as fast as they completed their charters on the coast, and water freights advanced sharply, reaching as high as $3.60 per ton, which, so far as the records show, was the highest in the history of the coal-carrying trade. This lack of coastwise tonnage resulted at times in a serious scarcity of coal, so that when the season closed neither the dealers nor the consumers had any appreciable quantity on hand.

RECEIPTS AND SHIPMENTS.

The receipts of coal at the port of Boston in 1915 were slightly less than in 1914. The anthracite and bituminous coal received in 1915 amounted to 7,652,218 net tons as against 7,940,117 net tons in 1914, a decrease of 287,899 tons. Of the receipts for 1915 1,906,690 tons were anthracite, 5,252,039 tons were bituminous, and 493,489 tons were foreign bituminous—a decrease of 234,218 tons of anthracite, a decrease of 257,485 tons of domestic bituminous, and an increase of 203,804 tons of foreign bituminous.

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The coal received for local consumption in Boston in 1915 amounted to 1,764,345 tons of anthracite and 4,570,847 tons of bituminous. In addition to the coal consumed locally in 1915 there was forwarded over the railroads from Boston to points in the interior of New England 142,345 tons, or about 7 per cent of the anthracite, and 1,174,682 tons, or about 20 per cent of the bituminous coal.

The following table shows the receipts of both anthracite and bituminous coal at Boston in 1915, by months, the quantity forwarded to interior points, the net receipts for local consumption, and the total for 1915 as compared with the totals for the four preceding years:

Coal received and shipped at Boston in 1915, in net tons.

Month and year.	Received from all points.		Forwarded to New England points.		Net receipts (for local consumption).	
	Anthracite.	Bituminous.	Anthracite.	Bituminous.	Anthracite.	Bituminous.
January	147,489	511,662	11,370	98,975	136,119	412,686
February	87,041	509,793	10,137	101,248	76,904	408,545
March	147,469	590,811	10,808	138,767	136,661	452,044
April	140,403	472,276	22,820	83,547	117,583	388,729
May	207,721	499,216	10,283	78,150	197,438	421,066
June	165,696	432,054	11,098	85,606	154,598	346,449
July	157,406	404,364	8,658	91,858	148,749	312,506
August	166,181	452,779	4,994	84,725	161,187	368,054
September	177,526	467,721	11,296	87,610	166,229	380,111
October	173,509	507,894	14,675	117,953	158,834	389,942
November	171,768	409,695	13,205	101,582	158,563	308,113
December	164,481	487,263	13,001	104,661	151,480	382,602
Total, 1915	1,906,690	5,745,528	142,345	1,174,682	1,764,345	4,570,847
1914	2,140,908	5,799,209	201,008	1,300,219	1,939,900	4,498,990
1913	2,076,984	5,892,928	110,033	1,202,692	1,966,951	4,690,236
1912	1,925,428	5,441,951	159,496	1,321,030	1,765,932	4,120,921
1911	2,220,993	4,967,302	276,203	1,383,455	1,933,490	3,583,847

The foreign coal received at Boston came, as usual, from the bituminous mines of the Dominion Coal Co., Cape Breton Island, Nova Scotia. Practically the entire quantity was consigned to the by-product coking plant at Everett, a suburb of Boston. The following tables show the receipts of domestic and foreign coals at the port of Boston for a period of five years, and the ports from which the domestic coal was shipped.

Coal received at Boston, Mass., 1911–1915, in net tons.

Year.	Domestic.				Foreign bituminous.	Total.
	By water.		By rail.			
	Anthracite.	Bituminous.	Anthracite.	Bituminous.		
1911	2,107,579	4,593,955	113,314	77,823	295,524	7,188,195
1912	1,740,655	5,012,582	184,773	83,148	346,221	7,367,379
1913	1,877,468	5,538,049	199,516	52,861	302,018	7,969,912
1914	1,925,391	5,450,791	215,517	58,733	289,685	7,940,117
1915	1,691,155	5,163,128	215,535	88,911	493,489	7,652,218

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Tidewater coal received at Boston in 1915 in net tons.

Port of origin.	Anthracite.	Bituminous.[a]	Total.
Baltimore, Md.	.....	1,301,023	1,301,023
Cornwall, N. J.	19,573	.....	19,573
Guttenberg, N. J.	122,895	.....	122,895
Hampton Roads, Va.	.....	3,370,051	3,370,051
Hoboken, N. J.	37,762	.....	37,762
New York, N. Y.	265,848	2,371	268,219
Perth Amboy, N. J.	167,246	.....	167,246
Philadelphia, Pa.	614,532	452,398	1,066,930
Port Johnson, N. J.	201,441	.....	201,441
Port Reading, N. J.	12,380	.....	12,380
St. George, S. I.	.....	15,326	15,326
South Amboy, N. J.	20,614	9,860	30,474
Undercliff, N. J.	228,864	.....	228,864
Washington, D. C.	.....	12,099	12,099
	1,691,155	5,163,128	6,854,283

[a] Does not include imports from Canada.

ANTHRACITE.

The retail prices of anthracite at Boston in 1915 were 25 cents a ton higher than in 1914. This increase, which was made in December, was the natural consequence of the increase in coastwise freights. On April 1 the prices of all sizes were, as usual, reduced 50 cents a ton. On July 1 the prices of all sizes were advanced 25 cents a ton, another advance of 25 cents a ton was made August 16, and a still further advance of 25 cents a ton was made on December 15. There has also been a considerable increase in the cost of labor, not only for miners but for the seamen employed in the coastwise trade and for the local coal handlers.

COASTWISE FREIGHT RATES.

The coastwise freight rates in 1915 were the highest in the history of the coal-carrying trade. One local dealer made a contract for three vessels, of six to seven thousand tons capacity each, for one trip between Philadelphia and Boston at $3 a ton, with a guaranty to load and discharge the vessels within three days and to pay a demurrage penalty of $2,500 a day for each day in excess of the time specified.

In September the coastwise freights began to advance. By December there were only a very few coal vessels above a thousand tons that had not chartered offshore. Instead of being chartered at a rate per diem, some coalers were chartered at a rate per ton or per trip, for one trip at a time, usually between voyages offshore. Many vessels that were about to be abandoned were bought up and put into service. The profits on offshore charters and on sales of ships were enormous. In September it was said that there were more American bottoms offshore than in any year since 1863.

The minimum rate from Hampton Roads in 1915 was 70 cents a ton and the maximum was $3.50 a ton; the rates in 1914 ranged from 55 cents to 80 cents. The rates per ton in 1915 from Philadelphia ranged from 70 cents to $3.25; in 1914 they were 55 cents to 90 cents per ton. The rates from Baltimore in 1915 ranged from 75 cents to $3.60 a ton; in 1914 they were 60 cents to 85 cents.

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BUFFALO.

By JOHN W. CHAMBERLAIN, trade-journal correspondent.

The sudden spurt given to the bituminous coal market late in 1915 by the increased activity in the iron trade makes it possible to give a more favorable account of the trade as a whole in 1915 than in 1914, though a great part of the improvement took place after the close of the calendar year 1915. The Canadian demand, especially for bituminous coal, fell off heavily soon after the European war began and has not yet recovered, but the domestic consumption and the export demand at tidewater more than made up that loss.

The Buffalo trade has taken part in that double change in a very odd way. As soon as the reduction of ocean traffic began to cut down tidewater receipts of coal in New England western Pennsylvania coal that could be shipped by rail into that region advanced in price to as much as $2 a ton. Buffalo began to use coal from the Ohio fields—such grades as No. 8 Bessemer and Panhandle, which were unable to take advantage of the New England stress, as they had no rates to that territory. The western market for these coals was dull, so they were offered to the Buffalo market at prices but little greater than the former prices of Pittsburgh and Allegheny Valley coals, which are the regular fuel for this market. These prices were maintained until the extreme shortage in New England was over, when something like former prices were again asked for Pittsburgh and Allegheny Valley coals.

Buffalo proper is a selling and passing point rather than a consuming center for both anthracite and bituminous coal. Natural gas supplies about half the normal demand for anthracite, and electric power from Niagara Falls seriously curtails the market for both. These conclusions must still be reached by estimate, as no figures are available in either trade, except those for the shipments of anthracite by water. The shipments of anthracite by Lake in 1915 were 3,674,737 net tons, according to the customhouse report, of which 208,825 tons went to Canadian ports. The water shipments from Erie, Pa., were 640,000 net tons, and those from Lake Ontario ports (Oswego and Fair Haven) were 835,400 tons, of which 240,000 tons passed up the Welland Canal to upper Lake ports, the rest going to ports on Lake Ontario and St. Lawrence River. The total shipments of anthracite from Lake ports were therefore 5,150,000 net tons.

In 1915 Buffalo received by rail about 8,500,000 tons of bituminous coal—an increase over the quantity received in 1914—and 6,200,000 tons of anthracite. The freight rate per ton on anthracite from the mines was $2, on bituminous coal from the Pittsburgh district $1.25, on bituminous coal from the Allegheny Valley district $1.10, and on coke from the Connellsville district $1.85. The statistics of exports are the official figures.

Coal and coke exported from Buffalo to Canada, 1907–1915, in net tons.

Year.	Anthracite.	Bituminous coal.	Coke.	Year.	Anthracite.	Bituminous coal.	Coke.
1907	906,295	2,881,344	229,399	1912	1,382,712	2,922,866	474,347
1908	880,391	1,933,492	239,357	1913	1,808,997	3,255,484	532,467
1909	896,830	1,968,610	392,095	1914	1,674,923	2,841,315	379,150
1910	1,043,143	2,256,533	471,302	1915	1,859,870	2,496,830	469,187
1911	1,898,439	2,935,215	465,997				

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CLEVELAND.

The consumption of anthracite, bituminous coal, and coke at Cleveland, Ohio, increased in 1915 as compared with 1914 and was exceeded in only one year, 1913. In addition to being a large coal-consuming center, Cleveland is one of the ports on Lake Erie where coal arriving in large shipments by rail from the mines in Ohio, Pennsylvania, West Virginia, and Kentucky is loaded in vessels for the upper Lake trade.

The shipments by water from Cleveland in 1915 were 1,665,681 net tons, a decrease from 1914, when they were 2,353,858 tons, and from 1913, when they were 4,677,925 tons. The data from which the following table was compiled were furnished by Munson Havens, secretary of the Cleveland Chamber of Commerce.

Coal and coke received, shipped, and consumed at Cleveland, Ohio, 1911–1915, in net tons.

Year.	Receipts.				Shipments.		
					By rail.		
	Anthracite.	Bituminous.	Total coal.	Coke.	Anthracite.	Bituminous.	Total.
1911	168,208	6,242,910	6,411,118	911,477	.....	.....	.....
1912	150,647	6,673,940	6,824,587	1,753,247	.....	118,623	118,623
1913	140,227	8,822,355	8,962,582	854,575	46,409	176,665	223,074
1914	88,913	5,658,769	5,747,682	626,953	.....	.....	.....
1915	151,173	5,093,106	5,244,279	703,603	13,727	7,671	21,398

Year	Shipments.			Local consumption.	
	By rail (coke).	By lake (bituminous).	Total coal.	Coal.	Coke.
1911	273,313	3,108,741	3,108,741	3,302,377	638,164
1912	288,238	4,249,666	4,368,289	2,456,298	1,465,009
1913	85,308	4,677,925	4,900,999	4,061,583	769,272
1914	71,513	2,353,858	2,353,858	3,393,824	555,440
1915	8,756	1,655,681	1,687,079	3,557,200	694,847

CINCINNATI.

Cincinnati is the "gateway" through which large quantities of coal pass from West Virginia, Pennsylvania, and Kentucky, with some from Tennessee, to markets in Michigan, Ohio, and Indiana, and to the Great Lakes for transshipment by vessel to the Middle Northwest. The statistics of movements of coal to and through Cincinnati contained in the annual report of W. C. Culkins, executive secretary of the Cincinnati Chamber of Commerce, show that in 1915 the receipts of coal from the Pittsburgh district by water were 218,121 net tons, a decrease, compared with 1914, of 76,564 tons; that the receipts by water from the Kanawha district (W. Va.), were 4,041,463 tons, an increase over 1914 of 2,700,213 tons, and that the receipts by rail were 13,542,193 tons, more than double the receipts by rail in 1914. The total receipts of bituminous coal at Cincinnati in 1915

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were 17,794,861 net tons and the shipments were 11,827,780 tons, the difference between which, 5,967,081 tons, may be considered to represent the consumption of bituminous coal in the Cincinnati district in 1915. The receipts of Pennsylvania anthracite were 6,916 net tons, all of which, it is assumed, was used in the city. The smoke ordinances of Cincinnati are very strict, and as a result a large part of the coal consumed in the city is semibituminous or "smokeless" coal from West Virginia.

Coal received and shipped at Cincinnati, 1911–1915, in net tons.

Year.	Receipts.						
	By river.			By rail.			Aggregate.
	Pittsburgh.	Kanawha.	Total.	Anthracite.	Bituminous.	Total.	
1911	729,748	1,536,551	2,266,299	6,280	5,206,421	5,212,701	7,479,000
1912	501,640	1,313,981	1,815,621	8,640	6,009,253	6,026,533	7,842,154
1913	428,737	1,507,257	1,935,994	13,689	6,197,143	6,224,521	8,160,515
1914	294,685	1,341,250	1,635,935	20,900	6,067,120	6,088,020	7,723,955
1915	218,121	4,041,463	4,259,584	6,916	13,535,277	13,542,193	17,801,777

Year.	Shipments.		
	By river.	By rail.	Aggregate.
1911	246,076	4,077,342	4,323,418
1912	279,842	4,396,859	4,676,701
1913	357,313	4,341,462	4,698,775
1914	326,215	4,548,557	4,874,772
1915	287,660	11,540,120	11,827,780

MILWAUKEE.

The coal docks at Milwaukee annually handle about 5,000,000 tons of coal, which comes by vessel from lower Lake ports. The greater part of this is consumed in the Milwaukee district, the remainder going by rail to interior points. In 1915, according to figures published by the Milwaukee Chamber of Commerce, there was received at Milwaukee 1,149,237 tons of Pennsylvania anthracite and 4,121,308 tons of bituminous, a total of 5,270,545 tons, which, compared with the receipts in 1914, was a decrease of 89,549 tons, or nearly 2 per cent. The receipts of both anthracite and bituminous coal decreased. Practically all the anthracite is received on vessels from Buffalo, only a small quantity coming from Oswego and Erie. About 92 per cent of the bituminous coal also comes by Lake and the remainder by car ferries from the terminals of the Pere Marquette and Grand Terminal railroads across Lake Michigan or by all-rail route through Chicago. The three railroads that serve Milwaukee directly—the Chicago, Milwaukee & St. Paul, the Chicago & North Western, and the Minneapolis, St. Paul & Sault Ste. Marie—transported 499,319 tons of anthracite and 1,156,587 tons of bituminous coal from Milwaukee to interior points, and 490 tons was shipped by Lake. The difference between receipts and shipments indicates a consumption in Milwaukee in 1915 of 649,918 tons of anthracite and 2,964,231

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tons of bituminous coal, a total of 3,614,149 tons. The consumption for 1914, similarly ascertained, was 3,873,844 tons, and the decrease in 1915 was 259,695 tons, or about 7 per cent.

Coal received at Milwaukee, 1911–1915, in net tons.

Source.	1911	1912	1913	1914	1915
By Lake from—					
Buffalo	909,080	834,131	1,028,491	950,701	984,968
Erie	90,342	367,527	153,602	191,646	194,525
Oswego	65,166	64,213	79,150	88,509	103,466
Cleveland	219,852	357,232	570,599	676,776	575,180
Ashtabula	446,330	242,297	486,739	354,149	288,556
Lorain	848,687	766,897	722,098	576,968	642,922
Sandusky	369,601	532,065	599,752	597,903	564,443
Toledo	1,453,631	1,180,596	1,228,153	1,237,635	1,251,285
Fairport	107,803	48,087	27,853	66,740	101,391
Huron	64,780	144,966	129,068	173,953	38,135
Other ports	30,150	44,727	203,265	35,698	120,334
Total Lake	4,605,422	4,582,688	5,228,770	4,950,578	4,865,205
By all rail	143,917	265,864	308,785	250,852	193,157
By car ferries	265,572	323,705	322,708	158,664	212,183
	5,014,911	5,172,257	5,860,263	5,360,094	5,270,545

Coal shipped from Milwaukee, 1911–1915, in net tons.

Shipped by—	1911	1912	1913	1914	1915
Chicago, Milwaukee & St. Paul Ry	765,980	248,768	394,734	763,132	922,819
Chicago & North Western Ry	543,840	577,225	495,100	581,908	620,982
Minneapolis, St. Paul & Sault Ste. Marie Ry. (Soo line)	119,135	129,607	104,003	135,865	112,105
Lake	60	178	6,762	5,345	490
	1,429,015	955,778	1,000,599	1,486,250	1,656,396

Coal received by Lake at Milwaukee, 1911–1915, by kinds, in net tons.

Kind.	1911	1912	1913	1914	1915
Anthracite	1,013,907	973,388	1,153,406	1,061,704	1,088,434
Bituminous	3,591,515	3,609,300	4,075,364	3,888,874	3,776,771
	4,605,422	4,582,688	5,228,770	4,950,578	4,865,205

NEW YORK CITY.

By FREDERICK HOBART, associate editor of the Engineering and Mining Journal.

GENERAL CONDITIONS.

In the first half of 1915 the coal trade of New York City was not satisfactory to dealers and operators; but in the second half there was a revival of activity in the coal business, due to the weather, to a large increase in manufactures, and to a general improvement in business conditions on the seaboard.

There were no material general changes in the New York trade during the year. In no other large city are the storage facilities for coal so insufficient, and therefore no other city depends so much on its daily receipts. The companies that deliver large shipments of coal at points

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on the harbor for local use store it on their docks, which soon become overloaded. Many of the city distributors take the coal directly from barges that bring it to their wharves, and nearly all the retail dealers have small storage yards and can carry little stock. No coal-carrying road enters the city, so that all its fuel must be delivered on the west side of the harbor and of Hudson River and must then be transferred to barges or floats which are towed to their points of destination. A few large coal-consuming plants are directly on the water front, but the final delivery to most consumers is of course made by wagons. The last step is not materially different from that made in other cities; the main difference in the movement is the extra transfer required and in the water transit.

The high cost of real estate would impose on dealers very heavy charges for interest or for rent should they wish to extend their storage space. Little bituminous coal is stored. Anthracite is stored, but the storage yards, which are maintained by railroads, are at Port Morris, South Plainfield, and other points from 25 to 50 miles from the city.

RECEIPTS, SHIPMENTS, AND CONSUMPTION.

Coal is delivered by rail to New York, as intimated above, not to the city but to the harbor ports—that is, to the coal docks along the New Jersey shore from South Amboy to Edgewater. The greater part of the coal that is consumed in or near the city comes by rail. Some cargoes reach New York from Hampton Roads, but most of them are in transit to New England or are intended for the bunker trade, which consumes a large quantity of Pocahontas and New River coal, which is usually transferred directly to ships. The statistics for the anthracite trade are fairly accurate, only a few small items being estimated; those for the bituminous trade are more difficult to obtain. It is believed, however, that the figures in the accompanying table are approximately correct.

Coal received, shipped, and consumed at New York City, in 1915, in net tons.

	Anthracite.	Bituminous.	Total.
Receipts at harbor points	15,864,800	11,116,000	26,980,800
Shipments coastwise	2,942,240	1,058,400	4,000,640
Bunker coal	308,000	4,110,400	4,418,400
Total shipments	3,250,240	5,168,800	8,419,040
Approximate consumption	12,614,560	5,947,200	18,561,760

Most of the coastwise shipments were made to New England ports. The offshore shipment of coal from New York is not large, but there were exports of 222,217 net tons of anthracite, 39,672 tons of bituminous, and 9,724 tons of coke in 1915. These are not included in the table.

ANTHRACITE TRADE.

The anthracite trade is so largely dependent on household demand that it is controlled in large degree by the weather. The winter of 1914–15 in the East was generally mild, and in the early part of

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1915 the market was inactive. This inactivity continued until March, when cold weather set in, bringing about a heavy demand. With this demand was combined an increase in manufacturing activity, which brought about a demand for coal of steam sizes. The period of activity extended into April, after the spring discounts took effect, when there was a strong demand for coal. In May, however, business quieted down and a dull period followed. Domestic consumers were not disposed or not prepared to take any advantage of the summer discounts. There was very little buying, and in June the collieries generally were running on short time and stocking a considerable part of their product. The low point of the trade during the year was reached in August. In September there was a little improvement; but it was not until October, when the weather became unusually cold, that there was a rush to buy—a rush that continued through the last quarter of the year. The trade then was beset with difficulties. The supply of cars was short, and the railroads were congested by the heavy export trade, so that the work of getting coal to tidewater in sufficient quantities was slow and difficult. On some shipments premiums of 25 or 35 cents a ton had to be paid, and the year closed with a strong demand which was very difficult to satisfy. The prospect for trade in 1916 was very good, for the current demand was large, and there was possibility of trouble when the anthracite agreement would expire on April 1, 1916, and this combination of conditions led some buyers to put in all possible stocks.

The list prices of prepared sizes of anthracite at New York Harbor ports remained unchanged at $5 a ton for broken, $5.25 for egg and stove, and $5.50 for chestnut. The usual summer discount of 50 cents a ton was made in April, and was diminished by 10 cents each month until September, when list prices were restored. The Pennsylvania State tax of 2.5 per cent on the value of the coal was added to the selling price. The range in prices for small or steam coal was $3.45 to $3.55 on pea, $2.45 to $2.80 on buckwheat, $1.95 to $2.30 on buckwheat No. 2 or rice, $1.70 to $1.80 per ton on barley.

The Pennsylvania tax of 2.5 per cent was pronounced unconstitutional by the State Supreme Court. A rehearing was asked and no final decision was rendered in time to affect the trade for 1915. The Pennsylvania Public Service Board ordered a heavy reduction in freight rates, but an appeal was taken to the courts, and the case was not decided before the close of the year. Another reduction in freight rates ordered by the Interstate Commerce Commission was also postponed until 1916.

Retail dealers in New York had rather an unhappy year. In addition to dull trade in the first half of the year they had to face unusual competition from agents of individual operators and brokers who sought to place orders directly with consumers at cost prices. These agents absorbed considerable trade. In the later months of the year, when trade revived, the retail men were faced by embargoes and slow deliveries, which often made it impossible to comply with the requirements of customers. Besides this their expenses were increased by advanced wages and higher cost of maintaining their unloading and delivering plants. Taken altogether there was little profit, and certainly no pleasure, in the retail anthracite trade in New York in 1915.

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BITUMINOUS COAL TRADE.

The bituminous coal trade in 1915 followed a course in some measure parallel to that of anthracite. The year opened with rather heavy stocks at docks, with only a moderate demand, and with prices low and uncertain. Contract deliveries were not urged as a rule, for manufacturing activity was evident in only a few special industries. The placing of contracts for large quantities of coal from Nova Scotia by the New York, New Haven & Hartford and the Boston & Maine Railroads made a marked reduction in the movement of coal through New York.

Throughout the first half of the year and through July and August also the trade continued slow and took only a few slight spurts. In September an improvement was manifest and activity continued to grow rapidly. Demand from manufacturers in New Lork and New England increased as their business increased, and sellers were in a position to insist on better prices. Their position was strengthened by the shortage of cars and the railroad congestion, which prevented coal from moving freely to New York Harbor. This shortage, however, favored the lower ports—Norfolk, Newport News, and Baltimore—at the expense of New York and Philadelphia. The prospect of labor troubles in the spring of 1916 also helped the market and made consumers eager to place contracts, but sellers were inclined to hold back and to avoid fixing prices too far ahead. Prices from September on increased rapidly and in December reached the highest points attained for many years.

The range of prices for the year was wide, the lowest being paid in January and the highest in December. Georges Creek Cumberland went from $3.10 to $4.55 f. o. b. New York Harbor; Fairmont, from $2.65 to $3.90; good Miller Vein Pennsylvania, from $2.75 to $4.30 per ton. In December the demand was so urgent that gas slack sold as high as $2 at the mines.

The bunker trade suffered on account of the war, which stopped the trips of a number of the large liners that usually coal at New York. This loss was partly compensated for by a gain in the number of freight steamships.

CONSUMPTION BY PUBLIC UTILITIES.

Reports to the Public Service Commission showed that in 1915 the electric light and power companies in the metropolitan district consumed 59,000 tons of anthracite and 995,000 tons of bituminous coal; and that the gas companies consumed 185,000 tons of anthracite and 848,000 tons of bituminous. The returns for the electric companies are fairly complete, but those for the gas companies require a good deal of estimating. These figures do not include the consumption in the power houses of the surface, subway, and elevated railroads, nor in those of the New York Central, New Haven, Pennsylvania and Long Island railroads. These roads consume not less than 900,000 tons yearly.

COASTWISE TRADE.

The coastwise trade was irregular throughout the year. The demand for seagoing vessels took from the trade all that were available for offshore work so that there was a scarcity of available vessels,

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even in the duller periods of the year. This scarcity threw upon the barge lines all the coal they could handle and they profited accordingly. Coal was taken from New York Harbor docks to Boston for 75 cents, $1, and even $1.25 a ton; that is, at rates from two to three times those paid in ordinary years. The coastwise trade from New York was dependent almost entirely on small towed barges and schooners. Steamers and even large sailing vessels were not to be had.

The year 1915 closed with trade active and prospects good for the coming year. The only drawbacks were delays in transportation and the congested condition of the railroads.

NORFOLK AND NEWPORT NEWS.

The well-known steam and "smokeless" bituminous coals mined in the southern part of West Virginia and in the southwestern counties in Virginia reach tidewater at the mouth of Chesapeake Bay over the Chesapeake & Ohio Railway to Newport News, the Norfolk & Western Railway to Lambert Point, and the Virginian Railway to Sewall Point. The Chesapeake & Ohio terminals are on the north side of Hampton Roads, at Newport News, and the others are on the south side near Norfolk.

The quantity of coal handled at Hampton Roads ports in 1915 was the greatest on record—16,278,484 net tons—being 2,889,274 net tons more than in 1914, when the high record of 13,389,210 net tons was made. Coastwise shipments decreased from 8,581,428 net tons in 1914 to 8,094,781 tons in 1915, but the increase in both export and bunker coal more than offset the decrease in coastwise trade. Shipments over the Virginian Railway to Sewall Point increased from 3,182,333 net tons to 3,490,819 tons; shipments over the Norfolk & Western to Lambert Point increased from 6,519,388 net tons to 8,208,883 tons; and shipments over the Chesapeake & Ohio Railway to Newport News increased from 3,687,489 to 4,578,782 net tons.

The figures included in the following tables were furnished by Messrs. Joseph W. Coxe, comptroller, Norfolk & Western Railway, at Roanoke, Va.; W. A. Young, superintendent coal terminals, Virginian Railway, at Sewall Point, Norfolk, Va.; and E. D. Hotchkiss, general freight agent, Chesapeake & Ohio Railway, at Richmond, Va.

Coal shipped from Hampton Roads, Va., by water in 1914 and 1915, in net tons.

1914.

Destination.	Norfolk & Western Ry.	Chesapeake & Ohio Ry.	Virginian Ry.	Total.
Coastwise	3,769,568	2,159,864	2,651,996	8,581,428
Export	1,912,541	987,516	173,555	3,073,612
Bunker	837,279	540,109	356,782	1,734,170
	6,519,388	3,687,489	3,182,333	13,389,210

1915.

Coastwise	3,390,239	2,057,301	2,647,241	8,094,781
Export	3,812,848	1,590,649	428,250	5,831,747
Bunker	1,005,796	930,832	415,328	2,351,956
	8,208,883	4,578,782	3,490,819	16,278,484

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Coal shipped from Sewall Point, Va., 1915, in net tons.

Month.	Coastwise.	Export.	Bunker.	Total.
January	239,723	3,059	34,343	277,125
February	218,772	5,389	40,078	264,239
March	233,270	8,160	28,813	270,243
April	207,852	28,075	45,481	281,408
May	198,051	17,003	30,532	245,586
June	207,884	17,716	35,506	261,106
July	226,439	78,017	31,756	336,212
August	246,347	62,976	30,346	339,669
September	246,201	65,693	37,180	349,074
October	206,474	49,157	39,450	295,081
November	162,389	51,350	32,289	246,028
December	253,839	41,655	29,554	325,048
	2,647,241	428,250	415,328	3,490,819

Coal shipped from Lambert Point, Va., 1915, in net tons.

Month.	Coastwise.	Export.	Bunker.	Total.
January	276,811	102,972	64,487	444,270
February	270,153	92,399	53,048	415,600
March	318,851	190,254	74,135	583,240
April	232,022	365,278	94,539	691,839
May	289,067	380,610	91,166	760,843
June	317,211	510,287	92,832	920,330
July	291,634	514,666	100,873	907,173
August	313,940	438,689	105,513	858,142
September	274,662	429,587	98,768	803,017
October	248,371	359,466	82,629	690,466
November	298,132	208,241	73,092	579,465
December	259,385	220,399	74,714	554,498
	3,390,239	3,812,848	1,005,796	8,208,883

Coal shipped from Newport News, Va., 1915, in net tons.

Month.	Coastwise.	Export.	Bunker.	Total.
January	154,345	34,047	62,362	250,754
February	135,597	86,163	71,036	292,796
March	179,072	92,316	70,487	341,875
April	126,603	116,441	108,979	352,023
May	229,059	106,182	72,281	407,522
June	156,680	140,513	86,775	383,968
July	137,191	259,289	89,610	486,090
August	154,321	242,958	116,467	513,746
September	160,383	176,312	76,660	413,355
October	195,338	108,095	60,242	363,675
November	213,312	108,281	55,444	377,037
December	215,400	120,052	60,489	395,941
	2,057,301	1,590,649	930,832	4,578,782

PANAMA CANAL.

The following table showing the shipments of coal through the Panama Canal in 1915 has been compiled from the Canal Record, the official publication of the Panama Canal. The shipments from January 1 to the end of September, when the canal was closed to shipping, were 309,839 net tons from the Atlantic to the Pacific and 6,944 tons from the Pacific to the Atlantic, a total of 316,783 tons. In 1914, from the time the canal was first opened, in August, to the end of the year, 112,563 net tons were transported through the canal, all from the Atlantic to the Pacific. The average quantity carried in

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1915 was 39,000 tons a month; the average in 1914 was 37,000 tons a month. Of the coal shipped through the canal in 1915, 49,629 tons was from Jamaica and 11,648 tons from Cardiff, a total of 61,277 tons, probably all English coal; 3,024 tons was from Guantanamo and 245,538 tons was from Atlantic coast ports of the United States, a total of 248,562 tons of American coal. The three shipments from the Pacific to the Atlantic were made in naval colliers.

The greater part of the coal from the Atlantic seaboard was destined for the Pacific coast of the United States—91,911 tons was consigned to San Francisco Harbor, including Tiburon, and 52,849 tons was consigned to other ports from San Diego to Puget Sound. Cargoes shipped to the west coast of South America amounted to 58,008 tons, all from the United States; 11,846 tons was shipped to Honolulu, and 23,668 tons to Manila.

Coal shipped through the Panama Canal in 1915, in net tons.

From Atlantic to Pacific.

Date.	From—	To—	Quantity.	Date.	From—	To—	Quantity.
Jan. 4	Norfolk	Honolulu	11,846	June 29	Philadelphia	Bremerton	5,936
16	Boston [a]	San Francisco	4,798	30	Cardiff	Balboa	5,712
19	Jamaica [a]	Panama	7,952	July 9	U. S. Navy	Manila	11,200
22	Jamaica	do [a]	6,372	11	Baltimore	Seattle	4,480
29	Norfolk	San Francisco	1,028	11	Newport News	San Francisco	2,190
Feb. 7	do	do	2,047	17	Jamaica	Pacific Ocean	5,561
Mar. 5	Philadelphia	do	2,059	23	Norfolk	Callao	3,898
8	Newport News	do	9,299	28	Newport News	Tiburon	6,304
9	Jamaica	Pacific Ocean	2,168	29	Baltimore	San Francisco	2,324
18	do	do	6,020	29	do	do	1,011
21	do	do	6,720	Aug. 1	Norfolk	do	8,083
27	Norfolk [b]	San Francisco	6,720	2	Jamaica	Pacific Ocean	3,752
Apr. 13	Baltimore	Seattle	2,040	8	Norfolk	Arica	1,898
14	Newport News	San Francisco	7,986	9	do	Antofagasta	6,048
21	Cardiff	Pacific Ocean	5,036	19	Baltimore	Guayaquil	6,720
May 26	Newport News	San Francisco	2,174	22	do	San Diego	3,130
27	do	do	7,824	29	Newport News	do	7,849
29	Philadelphia	do	2,424	30	Norfolk	Cavite	12,468
29	Newport News	San Diego	1,987	Sept. 4	do	Taltal (Chile)	9,226
31	Norfolk	do	8,176	7	do	San Francisco	638
June 2	do	Valparaiso	1,226	10	New York	Caleta Colusa	7,254
4	Jamaica	Sea	6,272	13	Jamaica	Vancouver	4,813
5	Norfolk	San Francisco	6,909	14	Norfolk	Taltal	7,260
6	do	Callao	3,118	18	Baltimore	Seattle	2,227
10	do	Tiburon	8,302	20	Norfolk	Puget Sound	8,400
14	Guantanamo	Guam Lake	3,024	21	do	Antofagasta	7,061
19	Newport News	Tiburon	2,146	23	do	Guaymas	2,255
25	Norfolk	Callao	4,144	24	Baltimore	Mollendo	5,155
28	do	San Diego	8,625				
29	do	Tiburon	8,344				309,839

[a] For orders. [b] Coal exhibits.

From Pacific to Atlantic.

Mar. 1	Manzanillo	Jamaica	1,792	Mar. 10	Seattle	New York	1,120
1	Punta Arenas	do	4,032				
							6,944

The following table showing the coal received at the Isthmus of Panama in 1915 and that used on the isthmus and sold to ships for bunker fuel is published through the courtesy of Mr. T. H. Rossbottom, secretary of the Panama Railroad Co.

The receipts in 1915 were 577,022 net tons, as against 287,781 in 1914. The stock on hand December 31, 1914, was about 67,000 tons,

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which, added to the excess of receipts over sales and the coal used in 1915, or 218,066 tons, indicates a stock of about 285,000 tons on December 31, 1915.

Coal received and sold by Panama Railroad Co. at the Isthmus of Panama in 1915, in net tons.

Months.	Received.	Used on Isthmus and delivered to steamers at Cristobal.	Delivered to steamers at Balboa.
January to March	91,076	59,846	13,746
April to June	148,658	73,161	9,803
July to September	161,522	90,508	20,806
October to December	175,766	23,902	67,182
	577,022	247,417	111,539

PHILADELPHIA.

No data are available to show the quantity of bituminous coal consumed at Philadelphia in 1915. The quantity of anthracite consumed in Philadelphia and vicinity in 1915, according to figures furnished by E. W. Parker, director, Anthracite Bureau of Information,[1] was 4,476,002 net tons, an increase compared with 1914 of 138,430 tons.

Philadelphia ranks second in shipments of bituminous coal by water. According to figures furnished to the Geological Survey, nearly 8,400,000 net tons of bituminous coal was loaded into vessels at that port in 1915, of which more than 6,300,000 tons, or 75 per cent, was destined for coastwise trade or for points on Delaware Bay. The coal is received at the harbor front over the Pennsylvania Railroad, the Philadelphia & Reading Railroad, and the Baltimore & Ohio Railroad. The Baltimore & Ohio delivers coal from mines on its lines in Pennsylvania, West Virginia, and Maryland, and the Philadelphia & Reading Railroad delivers coal from the same States which originates on the Baltimore & Ohio Railroad and theWestern Maryland Railway. The coal shipped over the Pennsylvania Railroad is mined in Pennsylvania. Anthracite reaches Philadelphia Harbor over the Pennsylvania and the Philadelphia & Reading railroads. The shipments of anthracite by vessel from Philadelphia in 1915 were 2,502,602 net tons, of which 95,846 tons was for foreign export and 2,406,756 tons was for coastwise trade, mainly at New England points.

PITTSBURGH.

Pittsburgh and Chicago are the largest bituminous coal-consuming districts in the United States. More than 17,000,000 net tons was shipped into Pittsburgh in 1915, according to statistics compiled from reports made by the railroads. Compared with 1914, this was an increase of 2,000,000 tons, or 13 per cent. The shipments of coal from western Pennsylvania through Pittsburgh to points farther west decreased from 26,500,000 tons in 1914 to 25,000,000 tons in 1915

[1] Private communication.

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and the shipments eastward were about 13,400,000 tons, a slight decrease over those of the preceding year.

The writer is indebted to Lieut. Col. Francis R. Shunk, Corps of Engineers, United States Army, for the statement of the movement of coal through the locks of Monongahela River and at Davis Island Dam, and to the following railroad officials for the shipments by rail, from which the foregoing figures and the following table have been compiled: Messrs. R. H. Large, coal traffic manager, Pennsylvania Railroad Co., Philadelphia; W. L. Cromlish, coal and coke agent, Baltimore & Ohio Railroad Co., Pittsburgh; J. C. Venning, general ore and coal agent, Pennsylvania lines west of Pittsburgh, Pittsburgh; J. B. Nessle, general freight agent, Pittsburgh & Lake Erie Railroad Co., Pittsburgh; R. T. Hill, secretary and accountant, Pittsburgh, Chartiers & Youghiogheny Railway Co., Pittsburgh; S. P. Woodside, general freight agent, Wabash Pittsburgh Terminal Railway Co., Pittsburgh.

Coal shipped to and through Pittsburgh, 1910–1915, in net tons.

Destination.	1910	1911	1912	1913	1914	1915
By rail:						
To Pittsburgh district	6,139,959	5,142,412	7,778,450	8,203,091	6,501,759	7,190,952
To west of Pittsburgh	[a]22,683,276	[a]22,474,289	24,086,001	26,044,234	24,513,234	22,658,596
Total by rail	28,823,235	27,616,701	31,864,451	34,247,325	31,014,993	29,849,548
By Monongahela River locks:						
To Pittsburgh district	9,460,695	9,207,232	9,943,333	10,335,585	8,617,159	9,953,063
To west of Pittsburgh	1,770,305	2,816,975	1,993,350	2,589,335	1,982,825	2,351,255
Total by water	11,231,000	12,024,207	11,936,683	12,924,920	10,599,984	12,304,318
Total shipments	40,054,235	39,640,908	43,801,134	47,142,245	41,614,977	42,153,866
To Pittsburgh district:						
By rail	6,139,959	5,142,412	7,778,450	8,203,091	6,501,759	7,190,952
By water	9,460,695	9,207,232	9,943,333	10,335,585	8,617,159	9,953,063
Total to Pittsburgh district	15,600,654	14,349,644	17,721,783	18,538,676	15,118,918	17,144,015
To west of Pittsburgh:						
By rail	22,683,276	22,474,289	24,086,001	26,044,234	24,513,234	22,658,596
By water	1,770,305	2,816,975	1,993,350	2,589,335	1,982,825	2,351,255
Total to west of Pittsburgh	24,453,581	25,291,264	26,079,351	28,633,569	26,496,059	25,009,851
Total shipments to Pittsburgh and points west	40,054,235	39,640,908	43,801,134	47,172,245	41,614,977	42,153,866
Shipments, all rail, to points east of Pittsburgh	10,781,544	13,169,866	15,349,045	17,127,692	13,592,539	13,376,616

[a] Includes a small quantity of coal sent to Lake Erie points.

ST. LOUIS.

St. Louis and the immediate vicinity form the largest coal-consuming district in Missouri, the Kansas City district ranking second. Statistics furnished by Mr. William F. Saunders, secretary and general manager of the Business Men's League of St. Louis, show that more than 7,780,000 net tons of bituminous coal and nearly 190,000 net tons of anthracite were received at St. Louis in 1915. Nearly all the anthracite (177,006 tons) was used locally, only 12,472 tons having been shipped to places beyond St. Louis. Exact figures

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showing the distribution of the bituminous coal are not available, but the statistics collected by the United States Geological Survey and those furnished by the reports of the St. Louis Coal Traffic Bureau show that the total given above includes coal for railroad fuel and commercial coal destined for points beyond St. Louis. From the data available it is estimated that the St. Louis district consumed in 1915 approximately 4,250,000 net tons of bituminous coal, of which about 3,750,000 tons was from Illinois and a considerable quantity was from Kentucky.

Coal and coke received at St. Louis, Mo., 1908–1915, in net tons.

Year.	Bituminous.	Anthracite.	Coke.	Year.	Bituminous.	Anthracite.	Coke.
1908	7,129,055	236,036	162,280	1912	8,942,872	277,683	190,370
1909	7,418,268	236,040	171,570	1913	8,651,156	274,423	130,857
1910	7,945,680	289,463	191,190	1914	7,876,394	174,604	139,296
1911	7,798,309	487,030	192,425	1915	7,782,577	189,478	121,389

Prices per net ton of coal at St. Louis, Mo., 1913–1915.

Kind.	1913			1914			1915		
	Highest.	Lowest.	Closing.	Highest.	Lowest.	Closing.	Highest.	Lowest.	Closing.
Standard Illinois lump coal	$1.82	$1.32	$1.62	$1.62	$1.42	$1.52	$1.62	$1.42½	$1.52½
High-grade Illinois lump coal	2.67	1.67	2.32	2.32½	1.97½	2.32½	2.47½	2.07½	2.47½
Anthracite, large	6.95	6.45	6.95	6.95	6.45	6.95	6.95	6.45	6.95
Anthracite, small	7.20	6.70	7.20	7.20	6.70	7.20	7.20	6.70	7.20
Connellsville coke	5.40	5.25	5.25	5.30	5.30	5.30	5.05	5.15	5.15
New River coke	5.40	5.25	5.25						(a)
Kentucky coke	4.00	3.60	3.60	3.75	3.25	3.75	3.75	3.25	3.75
Gas coke	4.85	4.30	4.75	4.25	4.00	4.25	4.25	4.00	4.25

a No market here.

SAN FRANCISCO.

In San Francisco, as in other cities of the Pacific coast, petroleum has largely supplanted coal for making steam for railroads and manufactories, and coal is now employed almost entirely for domestic use. The total quantity of coal received in San Francisco in 1915 was 442,563 net tons. The bunker fuel used in both the foreign and the domestic trade amounted to about 168,500 tons, and the exports were 479 tons, a total of 168,979 tons loaded on vessels, which, subtracted from the receipts, indicates a consumption of about 273,600 net tons of bituminous coal. There is no record of the receipt of anthracite at San Francisco.

The statistics showing the shipments of coal by rail into San Francisco and other cities in California in 1915 have been furnished through the courtesy of Messrs. W. G. Barnwell, assistant freight traffic manager, Atchison, Topeka & Santa Fe Railway, at San Francisco; G. W. Luce, freight traffic manager, Southern Pacific Co., at San Francisco; and J. T. Hendricks, freight traffic manager, Western Pacific Railway, at San Francisco. The statistics of receipts of coal by water from Washington and Oregon have been furnished by Mr.

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L. M. King, secretary, San Francisco Chamber of Commerce, and the imports of foreign coals by the Bureau of Foreign and Domestic Commerce, Department of Commerce.

Coal received at San Francisco in 1915.

	Net tons.		Net tons.
British Columbia	164,130	Eastern United States	103,183
Australia	106,768		
Great Britain	3,644	Total from the United States	104,894
Japan	22		
Total from foreign countries	274,564	Total receipts by water	379,458
		Receipts by rail	63,105
Washington	1,353	Total receipts	442,563
Oregon	358		

CONSUMPTION OF COAL BY THE UNITED STATES GOVERNMENT.

By G. S. Pope, engineer in charge of fuel inspection, Bureau of Mines.

The United States Government purchases annually 2,500,000 tons of coal, which costs about $9,000,000. The Navy, War, Treasury, Interior, Commerce, and Labor Departments and the Panama Railroad Co. are large consumers, and each department buys coal through its purchasing office. Much of the coal used by the Government must be delivered by wagons, and the business is therefore limited to dealers who have hauling facilities, especially in the city of Washington, where coal is purchased principally for heating and lighting public buildings.

The Navy Department, through the Bureau of Supplies and Accounts, purchases coal in cargo lots for naval stations and the ships of the Navy, and in car lots for use in the navy yards. The Marine Corps purchases considerable quantities of coal for barracks and stations.

Coal for use in the Canal Zone is purchased by the Panama Railroad Co. at Atlantic ports in the United States. At present it is shipped from Norfolk and Newport News, Va.

The Quartermaster Corps of the War Department buys coal for the many forts and Army posts in the United States and its foreign possessions and for ships in the Army Transport Service. The United States Engineer Office purchases coal for dredges and other floating plants, fortifications, and stationary plants, and for other uses required in river and harbor improvements and other construction work. The Ordnance Bureau buys large quantities of coal in car lots for the arsenals.

The coal bought by the Treasury Department is largely delivered in wagons to post offices, customhouses, United States courthouses, mints, and other Federal buildings throughout the country. The department also buys coal for the Coast Guard Service.

The Department of Commerce purchases coal for the vessels of the Coast and Geodetic Survey and for the Bureau of Lighthouses. The Bureau of Fisheries uses anthracite and bituminous coal in small lots, delivered in cars to the bureau and to stations throughout the country.

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The Department of Labor purchases coal for the stations of the Immigration Service.

The Department of Justice buys coal in car lots for the Federal Penitentiaries.

The Interior Department purchases annually in Washington 20,000 tons of bituminous coal and 1,000 tons of anthracite. Outside of Washington the department contracts for coal to be delivered to Indian schools and agencies.

Most of the coal purchased by the Government is used for heating public buildings and for generating power, though it buys also small quantities of blacksmithing or forge coal.

The larger individual contracts call for bituminous coal and the small sizes of anthracite. The domestic sizes of anthracite are as a rule purchased in small lots and delivered mainly by wagons.

In the District of Columbia the General Supply Committee solicits bids for the requirements of the executive departments and other Government establishments in Washington, except for the navy yard, the Capitol power plant, the filtration plant, and the War College. The District government purchases the coal required by the public schools, fire department, water-pumping station, sewage-pumping station, workhouse, and other municipal buildings and establishments.

Estimated quantity of coal consumed in the District of Columbia by the Federal and District governments for the fiscal year 1915–16 in net tons.

	Bituminous.	Anthracite.	Total
General Supply Committee	80,640	32,480	113,120
District government	32,480	10,528	43,008
Navy Department [a]	30,800	3,360	34,160
Capitol power plant [a]	28,000	.....	28,000
Filtration plant [a]	4,480	.....	4,480
War College [a]	.....	2,744	2,744
Miscellaneous [a]	437	493	930
	176,837	49,605	226,442

[a] Contracts not under the General Supply Committee or the District government.

176,837 tons of bituminous coal, at average price of $2.81 per ton	$497,353.50
49,605 tons of anthracite, at average price (steam and domestic sizes) of $4.70 per ton	233,408.30
Total cost	730,761.80

The fuel purchased by the Government is selected and used to some extent in the most satisfactory manner, but largely in ways that are inefficient and wasteful. Some of it is used under expert supervision, but engineers competent to judge are of the opinion that the practices of the Government in the use of its fuel are in general open to improvements of the same order of magnitude as have been realized by many large users of fuel who have made centralized and persistent effort to reduce fuel costs.

The cost of fuel purchased under specifications for the use of the Government now aggregates $4,100,000 a year, and the cost of fuel of which samples are taken and submitted to the Bureau of Mines for analysis, in order to determine the character and quality of the coal furnished, aggregates $3,000,000 a year. In fact, information is now obtained regarding the quality of fuel purchased on almost

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all Government contracts large enough to warrant sampling, analysis, and tests of heating value.

The estimated quantities of coal purchased by the Federal and District governments under specifications during the fiscal year 1915–16 are shown in the following table. As indicating the advantages of such a method of purchasing coal, allowances ranging from a few hundred dollars on a single relatively small contract to $40,000 on a contract amounting to 500,000 tons have been made because the coal delivered was inferior to that specified in the contract. Many industrial consumers, who buy coal in small quantities compared to those purchased by the Government, give careful consideration to the selection, purchase, and utilization of coal, in order that the cost of heating and producing power may be reduced, for in the industrial world of to-day heat and power are manufactured, bought, and sold just like any other marketable commodity. The results obtained from the analysis and test of coal purchased under specifications and the economies effected in the utilization of coal under expert supervision on but a few contracts, amounting to a very small tonnage compared to the total coal purchased by the Government, indicate that by similar methods of purchase and expert supervision for the entire Government service a considerable saving, estimated at 5 per cent, or $400,000 a year, could readily be made. To obtain the best results the engineering problem involving the selection and utilization of fuel for the several departments of the Government should be assigned to one office, so that Government fuel requirements would be placed under uniform supervision.

Estimated quantities of coal purchased by the United States Government under specifications, fiscal year 1915–16.

Branch of Federal service.	Delivered within the District of Columbia.				Delivered outside of the District of Columbia.			
	Bituminous.		Anthracite.		Bituminous.		Anthracite.	
	Quantity (net tons).	Cost.	Quantity (net tons).	Cost.	Quantity (net tons).	Cost.	Quantity (net tons).	Cost.
Department of Agriculture	6,838	$20,033.75						
Department of Commerce			4,088	$14,547.50	37,688	$114,553.00	2,800	$8,750.00
Department of the Interior	33,824	92,586.00			19,813	63,524.00		
Department of Justice					24,080	53,555.00		
Department of the Navy	3,584	12,286.00			55,216	132,022.00	1,680	4,125.00
Department of the Treasury	17,248	48,860.00			46,368	117,528.00	7,840	18,690.00
Department of War:								
Filtration plant	4,032	10,404.00						
Ordnance Department					19,701	63,576.30	9,296	27,200.00
United States Engineer Office					149,856	403,105.00		
Quartermaster Corps					183,944	755,143.28	25,257	76,241.45
State, War, and Navy Building	2,464	7,788.00	2,688	8,376.00				
District government	16,912	50,445.00						
National Home for Disabled Volunteer Soldiers					101,248	217,816.00		
Panama Railroad Co					672,000	1,578,000.00		
Post Office Department			6,720	28,800.00				
Department of Labor			448	1,868.00			14,560	38,090.00
Independent establishments	22,400	68,135.00	8,400	33,300.00				
	107,302	310,537.75	22,344	86,891.50	1,309,914	3,498,822.58	61,433	173,096.45

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Delivered within the District of Columbia:			
Bituminous	tons	107,302	
Anthracite	do	22,344	
			129,646
Delivered outside of the District of Columbia:			
Bituminous	tons	1,309,914	
Anthracite	do	61,433	
			1,371,347
			1,500,993
Cost of coal delivered within the District of Columbia:			
Bituminous		$310,537.75	
Anthracite		86,891.50	
			$397,429.25
Cost of coal delivered outside of the District of Columbia:			
Bituminous		3,498,822.58	
Anthracite		173,096.45	
			3,671,919.03
			4,069,348.28

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COKE.[1]

By C. E. LESHER.

INTRODUCTION.

The year 1915 was without doubt one of the most important in the history of the manufacture of coke in the United States, not so much because of the quantity and value of the product but because of the awakening not only of the public at large but also of the makers and users of coke to the fact that this country has been the most backward of all great nations in the saving and utilization of the by-products to be obtained in distilling coal. The economic effects of the European conflict have forced upon the American people in a manner at once startling and effective the knowledge of this country's dependence on Europe and on Germany in particular for dye stuffs. The realization of the importance of these materials has been brought home to everyone by the items in the daily newspapers and the scarcity in the shops and stores of the usual profuse assortment of dyed goods. Public interest is growing in the establishment in this country of a dye industry as a measure of industrial preparedness in time of peace that may be convertible into an industry in explosives and therefore serve for military preparedness in time of war.

Coke ovens of the retort type supply the raw materials from which dyes and explosives are made, and interest centers upon the progress made in recent years in building up this industry. Since 1893, when the first by-product ovens were built in the United States, there has been a steady increase in the use of the by-product process in manufacturing coke, but it was not until 1915, with the advent of the war contracts for benzol and with the dye situation a matter of public concern, that those engaged in making and using coke came to a full realization of the wastefulness of the old process, recognized that the day of the beehive oven is passing, and that the future holds much of promise for the manufacturer of by-product coke.

If further evidence were necessary to show that 1915 was a turning point in the history of coke, it is offered by the changes that are forecast in the Connellsville coke trade. For many years that area in Pennsylvania has been foremost not only in the United States but in the world as a producer of coke—practically all of it made in beehive ovens—and Connellsville coke has been the recognized standard. Although fully aware of the wastefulness of the beehive method, the iron companies and independent operators have been loath to

[1] The product obtained from distillation or carbonization (in by-product ovens) or partial combustion (in beehive ovens) of bituminous coal that constitutes a fuel suitable for the blast furnace or foundry is the only coke considered in this series of reports. "Gas-house" coke is not included.

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erect expensive by-product ovens in the district, which it has been estimated contains a supply of coal of suitable quality sufficient for but 25 years. In 1915, however, some of the largest users of commercial coke decided upon the erection of by-product plants, doubtless inspired in large measure by the possible profits in the by-products. It is now evident that the trend in the near future will be away from the use of Connellsville beehive coke and toward the use of coke made in by-product ovens from Connellsville coal mixed with other coal. Connellsville coke will, of course, continue for years to be a large factor in the trade, more particularly in prosperous seasons, but in periods of small demand its importance will be greatly lessened after the proposed by-product ovens have been erected.

The greatest progress made in 1915 was in the recovery of benzol. Equipment for the recovery of the oils of this type was installed at 15 by-product plants, thus increasing the number from 15 in 1914 to 30 at the end of 1915, and more than 16,600,000 gallons were marketed during the year. The benzol plants in operation or under construction at the end of 1915 are sufficient to treble the output, compared with 1914. Although the number of active by-product ovens was only 894 greater at the end of 1915 than at the close of 1914, the production of by-product coke increased 25 per cent. The passing of the beehive oven is indicated by the fact that only 727 ovens of that type were built in 1915, compared with an average of 1,258 for the five preceding years.

ACKNOWLEDGMENTS.

This report contains the first statistics collected by the United States Geological Survey showing the geographic distribution of the consumption of coke. The schedules of inquiry for production were as usual sent to the operators in January, 1916. In March requests were sent out for data covering the kinds of coke produced and its distribution for consumption. For the promptness and completeness with which those engaged in the coke industry replied to both sets of inquiries particular credit and thanks are due. Some of the large selling companies and agents willingly prepared, at considerable expense, data showing where their product was shipped, and all of the large and most of the smaller producers submitted these extra reports. The data regarding monthly shipments of coke are furnished by 22 railroads entering the beehive coking districts, and the author wishes to acknowledge the regular and active cooperation of the officials of these roads. Grateful acknowledgment is also made to Mrs. H. L. Bennit, statistical clerk, for valuable assistance in preparing the statistical compilations.

REVIEW OF COKE INDUSTRY.

The quantity of coke produced in the United States in 1915 was 41,581,150 net tons, valued at $105,503,868, an increase, compared with 1914, of 7,025,236 tons, or 20 per cent, in quantity, and of $17,169,651, or 19 per cent, in value. By-product coke showed the larger gain, the total quantity, 14,072,895 tons in 1915, being an increase of 2,852,952 tons, or 25 per cent, over 1914. Beehive coke output in 1915 was 27,508,255 tons, a gain of 18 per cent, compared

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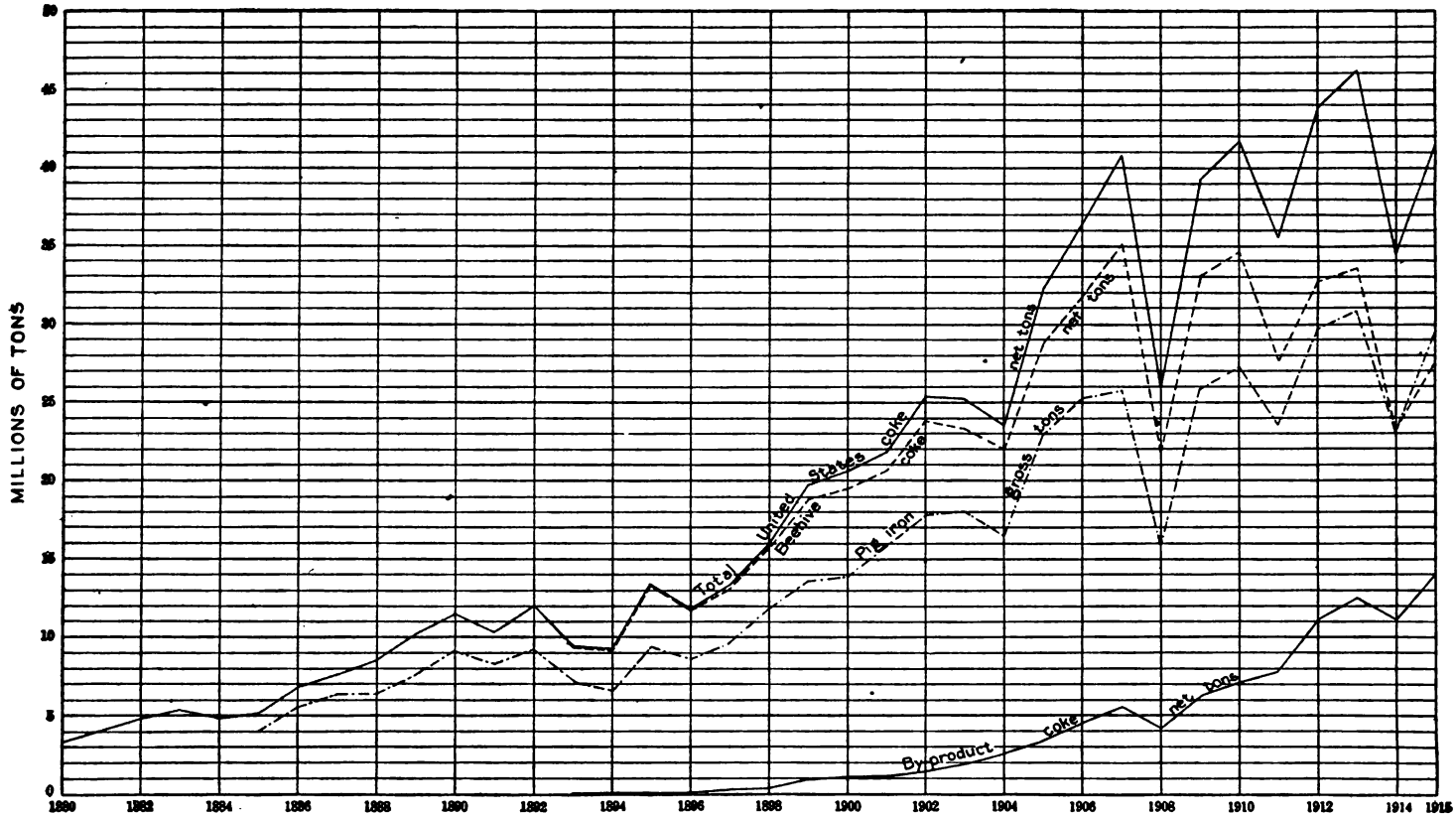

FIGURE 19.—Production of coke, beehive and by-product, and of pig iron in the United States, 1880–1915. Pig-iron statistics from American Iron and Steel Institute.

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with 1914. By far the greater part of the coke manufactured (about 90 per cent in 1915) is used in the iron furnaces of the country, and the quantity of coke made annually depends to a large extent upon the demand from the iron and steel trade. It follows, then, that the rate of production of coke should correspond closely to the rate of pig-iron output, and that this is true is indicated by the graphic record shown in figure 19.

The relation of the production of coke to that of pig iron is also strongly brought out by the curves in figure 20, which show by months

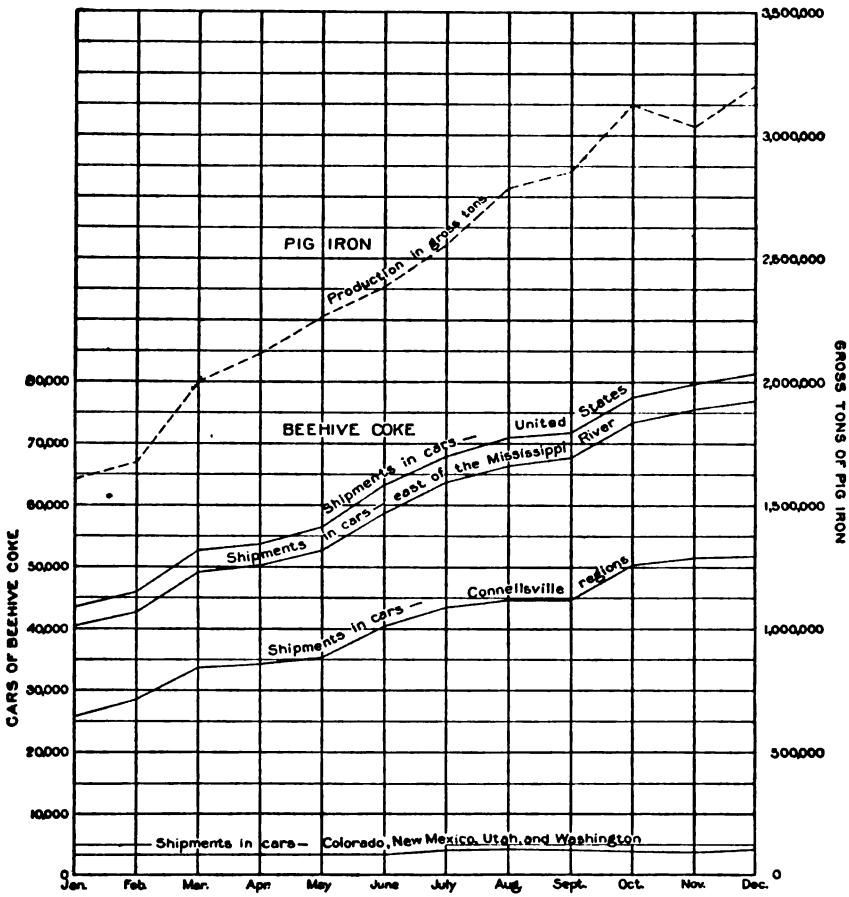

FIGURE 20.—Cars of coke shipped from beehive oven plants and monthly production of pig iron in 1915. Shipments from Connellsville region from the Connellsville Courier; other shipments compiled by the United States Geological Survey; statistics of pig iron from the Iron Age.

in 1915 the number of cars of beehive coke originating at the ovens and the quantity (in gross tons) of pig iron produced. From January to the end of the year the output of beehive coke steadily increased and pig iron showed gains in every month except November. The concordance of these curves is all the more remarkable when it is considered that by-product coke is not represented in figure 20. During the first four months of 1915 the gain was practically all in

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the Connellsville region. In May the coking districts outside of the Connellsville began to share in the prosperity, and from then to the end of the year there was steady progress. The beehive coke ovens west of the Mississippi, in Colorado, New Mexico, Utah, and Washington, had a fairly regular output, August showing slightly greater output than any other month. Pueblo, Colo., is the only locality west of the Mississippi where coke pig iron is made, and a large part of the coke produced in the West is used in the copper and lead blast furnaces.

The increase in output was general, except in a part of the South. Of those States whose record can be separately revealed, all but six had greater output in 1915 than in 1914. The decrease was small, except in Virginia, where the decline amounted to 151,000 tons, or 19 per cent. The other States in which there was decrease were Alabama, Georgia, and Tennessee, in the southern Appalachian region, and West Virginia, and Massachusetts. The increase in Pennsylvania, which State contributed nearly 62 per cent of the total output of the United States, was 5,364,000 tons, or 76 per cent of the total increase, and, in turn, the Connellsville district supplied a large part of Pennsylvania's increase.

The average value per ton at the ovens of the coke manufactured in 1915 was $2.54, a slight decrease from $2.56 in 1914. Alabama, Colorado, Illinois, Indiana, and Tennessee were the only States recording increase in value per ton.

PRODUCTION.

STATISTICS, 1880–1915.

In the following tables the statistics of beehive and of by-product coke are presented by States. Certain of the States have but one or two producers, and the returns from these operators are combined with others in order not to disclose the figures. Permission was requested and has been granted to publish as State totals the returns for by-product coke in Kentucky, Maryland, Massachusetts, Minnesota, New York, Tennessee, Washington, and West Virginia, and for beehive coke in Georgia. Thanks are due to the officials of the companies in these States for this courtesy.

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Coke produced in beehive and by-product ovens in the United States in 1914 and 1915.

1914.

State.	Beehive coke.				By-product coke.				Total.		
	Active ovens.	Coal used (net tons).	Coke produced (net tons).	Value of coke at ovens.	Active ovens.	Coal used (net tons).	Coke produced (net tons).	Value of coke at ovens.	Coal used (net tons).	Coke produced (net tons).	Value of coke at ovens.
Alabama	2,562	1,768,848	1,052,614	$3,329,606	750	2,909,348	2,031,535	$5,078,837	4,678,196	3,084,149	$8,408,443
Colorado	1,431	1,048,251	666,083	2,203,031	.....	.....	.....	.....	1,048,251	666,083	2,203,031
Georgia	100	45,298	24,517	100,529	.....	.....	.....	.....	45,298	24,517	100,529
Illinois	.....	.....	.....	.....	546	1,932,132	1,425,168	5,858,700	1,932,132	1,425,168	5,858,700
Indiana	.....	.....	.....	.....	767	3,125,207	2,276,652	9,055,937	3,125,207	2,276,652	9,055,937
Kentucky	487	392,168	247,182	477,301	54	280,456	196,777	493,759	672,624	443,959	971,060
Maryland	.....	.....	.....	.....	60	129,891	87,852	299,739	129,891	87,852	299,739
New Mexico	980	660,501	362,572	1,228,045	.....	.....	.....	.....	660,501	362,572	1,228,045
New York	.....	.....	.....	.....	267	659,418	457,370	1,726,133	659,418	457,370	1,726,133
Ohio	211	101,928	67,838	214,805	317	643,169	453,900	1,463,881	745,097	521,638	1,678,686
Pennsylvania	34,457	27,322,402	18,074,057	35,877,910	1,255	2,964,559	2,184,336	6,569,976	30,286,961	20,258,393	42,447,886
Tennessee	911	487,446	264,127	642,573	.....	.....	.....	.....	487,446	264,127	642,573
Virginia	2,191	1,319,901	780,984	1,582,419	.....	.....	.....	.....	1,319,901	780,984	1,582,419
Washington	241	(a)	(a)	(a)	5	(a)	(a)	(a)	133,349	84,923	472,531
West Virginia	5,199	2,251,995	1,381,675	2,705,992	120	64,314	46,287	141,292	2,316,309	1,427,962	2,847,284
Massachusetts	.....				400						
Michigan	.....				205						
Minnesota	.....	b 724,991	b 414,322	b 1,891,839	50	b 2,791,527	b 2,060,166	b 7,391,913	3,383,169	2,389,565	8,811,221
New Jersey	.....				150						
Utah	726				.....						
Wisconsin	.....				196						
	49,496	36,123,729	23,335,971	50,254,050	5,142	15,500,021	11,219,943	38,080,167	51,623,750	34,555,914	88,334,217

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Alabama	2,506	1,708,228	1,001,477	3,086,656	732	2,987,710	2,070,334	5,458,899	4,695,938	3,071,811	8,545,555
Colorado	1,334	1,026,019	670,938	2,242,453	.....	.....	.....	.....	1,026,019	670,938	2,242,453
Georgia	62	35,377	20,039	81,170	.....	.....	.....	.....	35,377	20,039	81,170
Illinois	.....	.....	.....	.....	626	2,335,933	1,686,998	7,016,635	2,335,933	1,686,998	7,016,635
Indiana	.....	.....	.....	.....	787	3,685,774	2,768,099	11,604,588	3,685,774	2,768,099	11,604,588
Kentucky	733	462,168	284,516	536,352	108	337,679	241,581	593,417	799,847	526,097	1,129,769
Maryland	.....	.....	.....	.....	120	470,326	313,283	762,664	470,326	313,283	762,664
Massachusetts	.....	.....	.....	.....	400	666,930	504,438	(a)	666,930	504,438	(a)
Minnesota	.....	.....	.....	.....	120	180,767	127,847	475,952	180,767	127,847	475,952
New Mexico	600	732,830	389,411	1,265,268	.....	.....	.....	.....	732,830	389,411	1,265,268
New York	.....	.....	.....	.....	555	975,656	684,461	2,459,463	975,656	684,461	2,459,463
Ohio	200	28,815	19,101	62,416	250	956,656	665,557	2,074,517	985,471	684,658	2,136,933
Pennsylvania	35,984	33,972,018	22,530,567	43,303,821	1,594	4,301,726	3,092,295	9,363,197	38,273,744	25,622,862	52,667,018
Tennessee	805	433,781	233,705	611,281	12	32,084	23,268	62,733	465,865	256,973	674,014
Virginia	1,516	995,396	629,807	1,242,938	.....	.....	.....	.....	995,396	629,807	1,242,938
Washington	249	(a)	(a)	(a)	5	(a)	(a)	(a)	204,879	136,552	700,832
West Virginia	4,270	2,071,001	1,250,235	2,348,468	120	202,762	141,211	412,337	2,273,763	1,391,446	2,760,805
Michigan	.....				205						
Missouri	.....				56						
New Jersey	.....	b 812,883	b 478,459	b 2,164,720	150	b 2,420,379	b 1,753,523	c 8,273,923	3,028,383	2,095,430	c 9,737,811
Utah	726				.....						
Wisconsin	.....				196						
	48,985	42,278,516	27,508,255	56,945,543	6,036	19,554,382	14,072,895	48,558,325	61,832,898	41,581,150	105,503,868

a Included in combined States.

b Includes also Washington.

c Includes also value of Massachusetts coke.

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Coke produced in the United States, 1912–1915, in net tons.

State.	1912	1913	1914	1915	Increase or decrease 1915.			
					Quantity.	Percentage.		
						Total.	Beehive.	By-product.
Alabama	2,975,489	3,323,664	3,084,149	3,071,811	− 12,338	− 0.4	− 4.9	+ 1.9
Colorado	972,941	879,461	666,083	670,938	+ 4,855	+ .7	+ .7	0
Georgia	43,158	42,747	24,517	20,039	− 4,478	− 18.3	−18.3	0
Illinois	1,764,944	1,859,553	1,425,168	1,686,998	+ 261,830	+ 18.3	0	+ 18.3
Indiana	2,616,339	2,727,025	2,276,652	2,768,099	+ 491,447	+ 21.6	0	+ 21.6
Kansas	(a)	0	0	0	0	0	0	0
Kentucky	191,555	317,084	443,959	526,097	+ 82,138	+ 18.5	+15.1	+ 22.8
Maryland	(a)	(a)	87,852	313,283	+ 225,431	+256.6	0	+256.6
Massachusetts	(a)	(a)	540,631	504,438	− 36,193	− 6.7	0	− 6.7
Michigan	(a)	(a)	(a)	(a)	(a)	+ 21.2	0	+ 21.2
Minnesota	(a)	(a)	(a)	127,847	(a)	.....	0	.....
Missouri	0	0	0	(a)	(a)	.....	0	.....
New Jersey	270,429	255,792	(a)	(a)	(a)	.....	0	.....
New Mexico	413,906	467,945	362,572	389,411	+ 26,839	+ 7.4	+ 7.4	0
New York	794,618	758,486	457,370	684,461	+ 227,091	+ 49.7	0	+ 49.7
Ohio	388,669	351,846	521,638	684,658	+ 163,020	+ 31.3	−71.8	+ 46.7
Pennsylvania	27,438,693	28,753,444	20,258,393	25,622,862	+5,364,469	+ 26.5	+24.7	+ 41.6
Tennessee	370,076	364,578	264,127	256,973	− 7,154	− 2.7	−11.5	.....
Utah	(a)	(a)	(a)	(a)	(a)	+ 11.5	+11.5	0
Virginia	967,947	1,303,603	780,984	629,807	− 151,177	− 19.4	−19.4	0
Washington	49,260	76,221	84,923	136,552	+ 51,629	+ 60.8	+32.7	+386.5
West Virginia	2,465,986	2,472,752	1,427,962	1,391,446	− 36,516	− 2.6	− 9.5	+205.1
Wisconsin	(a)	(a)	(a)	(a)	(a)	+ 6.2	0	+ 6.2
Combined States	2,259,589	2,345,329	1,848,934	2,095,420	+ 374,343	.....	.....	.....
	43,983,599	46,299,530	34,555,914	41,581,150	+7,025,236	+ 20.3	+17.9	+ 25.4

[a] Included in combined States.

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Coke produced in the United States, 1880–1915.

Year.	By-product coke.				Beehive coke.				Total.	
	Quantity (net tons).	Percentage to total.	Value.	Percentage to total.	Quantity (net tons).	Percentage to total.	Value.	Percentage to total.	Quantity (net tons).	Value.
1880..	0	0	0	0	3,338,300	100.0	$6,631,267	100.0	3,338,300	$6,631,267
1885..	0	0	0	0	5,106,696	100.0	7,629,118	100.0	5,106,696	7,629,118
1890..	0	0	0	0	11,508,021	100.0	23,215,302	100.0	11,508,021	23,215,302
1893..	12,850	0.1	.....	.....	9,464,730	99.9	.....	.....	9,477,580	16,523,714
1900..	1,075,727	5.2	$2,635,531	5.6	19,457,621	94.8	44,807,800	94.4	20,533,348	47,443,331
1905..	3,462,348	10.7	10,851,730	15.0	28,768,781	89.3	61,624,466	85.0	32,231,129	72,476,196
1910..	7,138,734	17.1	24,793,016	24.9	34,570,076	82.9	74,949,685	75.1	41,708,810	99,742,701
1911..	7,847,845	22.1	27,297,897	32.4	27,703,644	77.9	56,832,952	67.6	35,551,489	84,130,849
1912..	11,115,164	25.3	42,632,930	38.1	32,868,435	74.7	69,172,183	61.9	43,983,599	111,805,113
1913..	12,714,700	27.5	48,637,852	37.7	33,584,830	72.5	80,284,421	62.3	46,299,530	128,922,273
1914..	11,219,943	32.5	38,080,167	43.1	23,335,971	67.5	50,254,050	56.9	34,555,914	88,334,217
1915..	14,072,895	33.8	48,558,325	46.0	27,508,255	66.2	56,945,543	54.0	41,581,150	105,503,868

Statistics of the manufacture of coke in the United States, 1880–1915.

Year.	In operation.		Coal used (net tons).	Percentage yield of coke from coal.	Coke produced (net tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.
	Establishments.	Ovens.					
1880.....	[a] 186	[a] 12,372	5,237,741	63.0	3,338,300	$6,631,267	$1.99
1890.....	[a] 253	[a] 37,158	18,005,209	64.0	11,508,021	23,215,302	2.02
1900.....	345	43,039	32,113,553	63.9	20,533,348	47,443,331	2.31
1910.....	478	96,067	63,088,327	66.1	41,708,810	99,742,701	2.39
1911.....	391	63,480	53,278,248	66.7	35,551,489	84,130,849	2.37
1912.....	439	73,058	65,577,862	67.1	43,983,599	111,805,113	2.54
1913.....	444	72,008	69,239,190	66.9	46,299,530	128,922,273	2.78
1914.....	359	54,638	51,623,750	66.9	34,555,914	88,334,217	2.56
1915.....	354	54,967	61,832,898	67.2	41,581,150	105,503,868	2.54

[a] Total in existence. No statistics available showing idle establishments.

COKE IN PENNSYLVANIA.

About two-thirds of the output of coke in the United States is contributed by Pennsylvania, and of Pennsylvania's total more than 72 per cent is made in the three Connellsville districts, in Fayette, Westmoreland, and Indiana counties.

The output of coke in Pennsylvania in 1915 was 25,622,862 net tons, an increase, compared with 1914, of 5,364,469 tons, or 26 per cent. The Connellsville district proper recorded an increase of 2,113,362 tons, or 27 per cent; the Upper Connellsville district, 37,364 tons, or 6 per cent; and the Lower Connellsville, 1,765,638 tons, or 28 per cent. Coke from by-product ovens represented 12 per cent of the total output of the State and was an increase, compared with 1914, of 42 per cent.

There was a decrease of 1 in the number of establishments, 273 in 1915 against 274 in 1914, but an increase in the number of ovens of both beehive and by-product types from 54,075 to 54,856. At the close of 1915 there were 752 ovens in course of construction—212 by-product ovens of the Koppers type, at South Bethlehem; 440 in the Lower Connellsville region, of which 196 were rectangular ovens and the remainder beehive; and 100 beehive ovens in the Connellsville

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district. In the three Connellsville districts 135 ovens were abandoned during the year, and in the State those permanently dismantled numbered 189.

The statistics of the coke industry in the several districts of Pennsylvania in 1914 and 1915, and for the State and the Connellsville districts separately, during a period of years, are given in the following tables:

Coke produced in Pennsylvania in 1914 and 1915.

1914.

District.	Establishments.	Ovens. Built.	Ovens. Building.	Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Total value of coke at ovens.	Value of coke per ton.
Allegheny Mountain and Allegheny Valley	26	2,470	50	917,790	75.0	689,216	$1,993,276	$2.89
Connellsville	106	21,343	160	11,789,842	66.6	7,850,813	15,078,667	1.92
Lower Connellsville	76	16,037	445	9,296,713	65.5	6,224,224	11,557,006	1.86
Pittsburgh	14	4,558	.....	3,047,241	65.2	1,985,555	4,827,964	2.43
Upper Connellsville	20	2,552	.....	919,316	65.4	601,448	1,185,138	1.97
Other districts	32	7,115	212	4,316,059	67.4	2,907,137	7,805,835	2.68
	274	54,075	867	30,286,961	66.9	20,258,393	42,447,886	2.10

1915.

Allegheny Mountain and Allegheny Valley	28	[a]2,562	.....	1,538,558	69.8	1,074,405	3,152,611	2.93
Connellsville	103	[b]21,499	100	14,806,191	67.3	9,964,175	18,538,746	1.86
Lower Connellsville	76	[c]16,400	[d]440	11,930,691	67.0	7,989,862	14,359,435	1.80
Pittsburgh	14	[e]4,540	.....	3,966,992	64.1	2,552,427	6,122,562	2.38
Upper Connellsville	21	[f]2,746	.....	966,580	66.1	638,812	1,217,544	1.91
Other districts [g]	31	[h]7,109	[i]212	5,064,732	67.2	3,403,181	9,276,120	2.73
	273	54,856	752	38,273,744	66.9	25,622,862	52,667,018	2.06

[a] Includes 343 United-Otto, 92 Koppers, and 27 Gas Machinery ovens.
[b] Includes 110 Semet-Solvay and 1,120 rectangular ovens.
[c] Includes 2,635 rectangular ovens.
[d] Includes 196 rectangular ovens.
[e] Includes 332 United-Otto and 1,135 rectangular ovens.
[f] Includes 270 rectangular ovens.
[g] Includes Bedford, Cameron, Clearfield, Dauphin, Delaware, Elk, Huntingdon, Jefferson, Lebanon, Northampton, and a part of Allegheny, Indiana, and Westmoreland counties.
[h] Includes 250 Semet-Solvay, 228 United-Otto, 150 Didier, 212 Koppers, and 300 rectangular ovens.
[i] Koppers ovens.

Coke produced in Pennsylvania, 1880–1915.

Year.	Establishments.	Ovens. Built.	Ovens. Building.	Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Total value of coke at ovens.	Value of coke at ovens per ton.
1880	124	9,501	836	4,347,558	65.0	2,821,384	$5,255,040	$1.86
1890	106	23,430	74	13,046,143	65.6	8,560,245	16,333,674	1.91
1900	177	32,548	2,310	20,239,966	66.0	13,357,295	29,692,258	2.22
1910	288	55,656	1,334	39,455,785	66.7	26,315,607	55,254,599	2.10
1911	279	54,904	1,271	32,875,655	66.7	21,923,935	43,053,367	1.96
1912	277	53,756	1,887	41,268,532	66.5	27,438,693	56,336,255	2.05
1913	276	55,058	582	43,195,801	66.6	28,753,444	67,929,864	2.36
1914	274	54,075	867	30,286,961	66.9	20,258,393	42,447,886	2.10
1915	273	[a]54,856	[b]752	38,273,744	66.9	25,622,862	52,667,018	2.06

[a] Includes 903 United-Otto, 304 Koppers, 360 Semet-Solvay, 150 Didier, 27 Gas Machinery, and 5,460 rectangular ovens.
[b] Includes 212 Koppers and 196 rectangular ovens.

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Coke produced in the Connellsville region, Pa., 1880–1915.

Year.	Establishments.	Ovens.		Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Total value of coke at ovens.	Value of coke at ovens per ton.
		Built.	Building.					
1880	67	7,211	731	3,367,856	65.5	2,205,946	$3,948,643	$1.79
1890	28	15,865	30	9,748,449	66.3	6,464,156	11,537,370	1.94
1900	98	20,981	686	14,946,659	67.0	10,020,907	22,383,432	2.23
1910	118	24,481	206	17,205,615	66.6	11,459,601	23,121,556	2.02
1911	112	23,879	227	14,420,328	66.3	9,565,013	18,471,506	1.93
1912	109	22,219	148	17,772,202	66.5	11,814,588	22,463,602	1.90
1913	106	22,189	60	17,379,314	66.6	11,566,778	25,830,382	2.23
1914	106	21,343	160	11,789,842	66.6	7,850,813	15,078,667	1.92
1915	103	[a]21,499	100	14,806,191	67.3	9,964,175	18,538,746	1.86

[a] Includes 110 Semet-Solvay and 1,120 rectangular ovens.

The following table, compiled by the Courier, of Connellsville, Pa., shows the shipments of coke by months from the Connellsville and the Lower Connellsville districts. The figures are given in cars and tons, with the average number of cars shipped each working day of the month, and include shipments from the Lower Connellsville district as well as from the Connellsville district proper. This authority gives the shipments in 1915 as 17,921,216 net tons, whereas the combined production of the Connellsville and the Lower Connellsville districts as reported to the Geological Survey amounted to 17,954,037 net tons. It will be noted that (as shown also by fig. 20) each succeeding month showed increased production, and by November the shipments were almost double those in January of the same year. The record for January exceeded that for any month in the period 1911 to 1914 and was higher than for any month except January, 1910.

Coke shipped from the Connellsville and Lower Connellsville districts, 1911–1915, in net tons.

Month.	1911	1912	1913	1914	1915
January	1,194,047	1,546,892	1,868,149	1,222,282	940,781
February	1,302,098	1,560,182	1,715,917	1,270,107	1,045,739
March	1,621,301	1,747,959	1,728,709	1,594,267	1,258,559
April	1,419,369	1,697,734	1,730,183	1,423,048	1,268,292
May	1,343,879	1,776,415	1,817,805	1,198,651	1,310,639
June	1,299,295	1,635,824	1,685,635	1,129,821	1,486,845
July	1,257,320	1,564,377	1,710,435	1,189,834	1,618,199
August	1,355,774	1,704,307	1,696,368	1,157,942	1,657,203
September	1,394,752	1,555,483	1,649,368	1,112,653	1,683,414
October	1,424,232	1,782,302	1,719,045	1,028,764	1,851,938
November	1,385,627	1,736,888	1,496,000	823,595	1,873,405
December	1,335,974	1,692,510	1,280,287	924,674	1,926,202
	16,334,168	20,000,873	20,097,901	14,075,638	17,921,216

The total shipments in cars for the last 28 years, the total number of cars in 1914 and 1915, the daily car average, and the total number of tons shipped, as reported by the Courier, are shown in the following tables.

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Coke shipped from the Connellsville and Lower Connellsville districts, 1888–1915, in carloads.

Year.	Daily average.	Total.	Year.	Daily average.	Total.	Year.	Daily average.	Total.
1888	905	282,441	1898	1,415	441,249	1908	1,173	368,222
1889	1,046	326,220	1899	1,676	523,203	1909	1,920	600,979
1890	1,147	355,070	1900	1,619	504,410	1910	1,923	598,706
1891	884	274,000	1901	1,857	581,051	1911	1,570	448,672
1892	1,106	347,012	1902	1,986	624,198	1912	1,911	595,336
1893	874	270,930	1903	1,782	558,738	1913	1,872	582,071
1894	900	281,677	1904	1,623	510,759	1914	1,235	383,961
1895	1,410	441,243	1905	1,886	688,328	1915	1,557	483,958
1896	920	289,137	1906	2,385	745,274			
1897	1,181	367,383	1907	2,210	691,757			

Coke shipped from the Connellsville and Lower Connellsville districts, 1914 and 1915, in carloads.

Month.	1914		1915	
	Total.	Daily average.	Total.	Daily average.
January	33,537	1,249	25,511	981
February	34,848	1,452	28,463	1,186
March	43,962	1,691	33,934	1,257
April	39,599	1,523	34,288	1,315
May	32,936	1,267	35,078	1,349
June	30,749	1,183	40,097	1,542
July	32,181	1,238	43,448	1,671
August	31,212	1,200	44,574	1,714
September	30,023	1,155	45,479	1,749
October	27,749	1,028	50,167	1,929
November	22,177	887	51,244	1,971
December	24,988	976	51,675	1,987
	383,961	1,235	483,958	1,557

COKE IN WEST VIRGINIA.

The statistics of the manufacture of coke in the several districts of West Virginia are given in the following tables. Every district showed a decrease in 1915, compared with 1914, and the output in the State was the lowest since 1895.

There was a decrease of 5 in the number of establishments—from 118 to 113—and of 772 in the number of ovens. One by-product plant is located in West Virginia, at Benwood, and another is building at Follansbee, in the extreme northern part of the State.

Coke produced in West Virginia in 1914 and 1915.

1914.

District.	Establishments.	Ovens.		Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Total value of coke at ovens.	Value of coke at ovens per ton.
		Built.	Building.					
Flat top	51	10,584	.....	1,246,917	59.4	741,108	$1,396,501	$1.88
Kanawha	8	1,453	.....	204,631	61.8	126,422	258,214	2.04
New River	18	1,437	.....	195,109	59.9	116,865	321,624	2.75
Upper Monongahela	33	[a] 2,868	.....	472,933	64.9	306,833	663,632	2.16
Upper Potomac and Tygarts Valley	8	778	.....	196,719	69.5	136,734	207,313	1.52
	118	17,120	.....	2,316,309	61.6	1,427,962	2,847,284	1.99

[a] Includes 120 Semet-Solvay ovens.

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Coke produced in West Virginia in 1914 and 1915—Continued.

1915.

District.	Establishments.	Ovens. Built.	Ovens. Building.	Coal used (net tons).	Yield of coke from coal (per cent).	Coke produced (net tons).	Total value of coke at ovens.	Value of coke at ovens per ton.
Flat Top	41	7,695	.....	1,245,551	58.3	726,545	$1,317,892	$1.81
Kanawha	8	1,453	.....	259,863	57.7	149,899	371,427	2.48
New River	16	1,403	.....					
Tug River [a]	7	2,151	.....	.....	.....	.....	.....	.....
Upper Monongahela	33	[b] 2,868	[c] 94	584,757	66.4	388,105	873,180	2.25
Upper Potomac and Tygarts Valley	8	778	.....	183,592	69.1	126,897	198,306	1.56
	113	16,348	94	2,273,763	61.2	1,391,446	2,760,805	1.98

[a] Tug River district was idle in 1914. [b] Includes 120 Semet-Solvay ovens. [c] Koppers ovens.

RANK OF COKE-PRODUCING STATES.

Coke was produced in 1915 in 22 States; in 5 States only beehive ovens were used; in 10 the whole product came from by-product ovens; and in 7 States both methods of coke making were employed. In total output Pennsylvania heads the list, with Alabama, Indiana, and Illinois following in order. The same States rank highest as regards production from by-product ovens, Indiana, however, leading Alabama in that respect. The rank of the coke-producing States in respect of total and of by-product putput for the years 1911–1915 is shown in the following table. Michigan, Ohio, and New York moved up from ninth, eleventh, and twelfth place, respectively, in 1914, to sixth, seventh, and eighth in 1915, by reason of the increased output of by-product coke.

Rank of the States in the production of coke, 1911–1915.

State.	1911 Total.	1911 By-product.	1912 Total.	1912 By-product.	1913 Total.	1913 By-product.	1914 Total.	1914 By-product.	1915 Total.	1915 By-product.
Pennsylvania	1	1	1	1	1	1	1	1	1	1
Alabama	2	5	2	4	2	3	2	3	2	3
Indiana	6	3	3	2	3	2	3	2	3	2
Illinois	4	2	5	3	5	4	4	4	4	4
West Virginia	3	12	4	12	4	12	5	14	5	13
Michigan	12	8	11	8	11	8	9	6	6	5
Ohio	15	11	13	11	14	11	11	9	7	7
New York	8	4	8	5	8	5	12	8	8	6
Colorado	5	.....	6	.....	7	.....	7	.....	9	.....
Virginia	7	.....	7	.....	6	.....	6	.....	10	.....
Wisconsin	9	6	9	6	9	6	8	5	11	8
Kentucky	19	.....	18	.....	16	14	13	11	12	12
Massachusetts	10	7	10	7	10	7	10	7	13	9
New Mexico	11	.....	12	.....	12	.....	14	.....	14	.....
Utah	17	.....	15	.....	15	.....	15	.....	15	.....
Maryland	13	9	16	9	18	10	19	13	16	10
New Jersey	16	10	17	10	17	9	17	10	17	11
Tennessee	14	.....	14	.....	13	.....	16	.....	18	17
Washington	20	.....	20	.....	20	.....	20	15	19	16
Missouri	.....	.....	.....	.....	.....	.....	.....	.....	20	14
Minnesota	18	13	19	13	19	13	18	12	21	15
Georgia	21	.....	21	.....	21	.....	21	.....	22	.....
Kansas	22	.....	22	.....	.....	.....	.....	.....	.....	.....

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COKE OVENS IN THE UNITED STATES.

The number of beehive coke ovens [1] in the United States has been decreasing for years, independent of whether the output of coke rose or fell. By-product ovens have, however, increased in number each year since 1894. The greater advantages and economies of the newer process will continue to operate in the further decrease in beehive ovens, although very many years must elapse before they

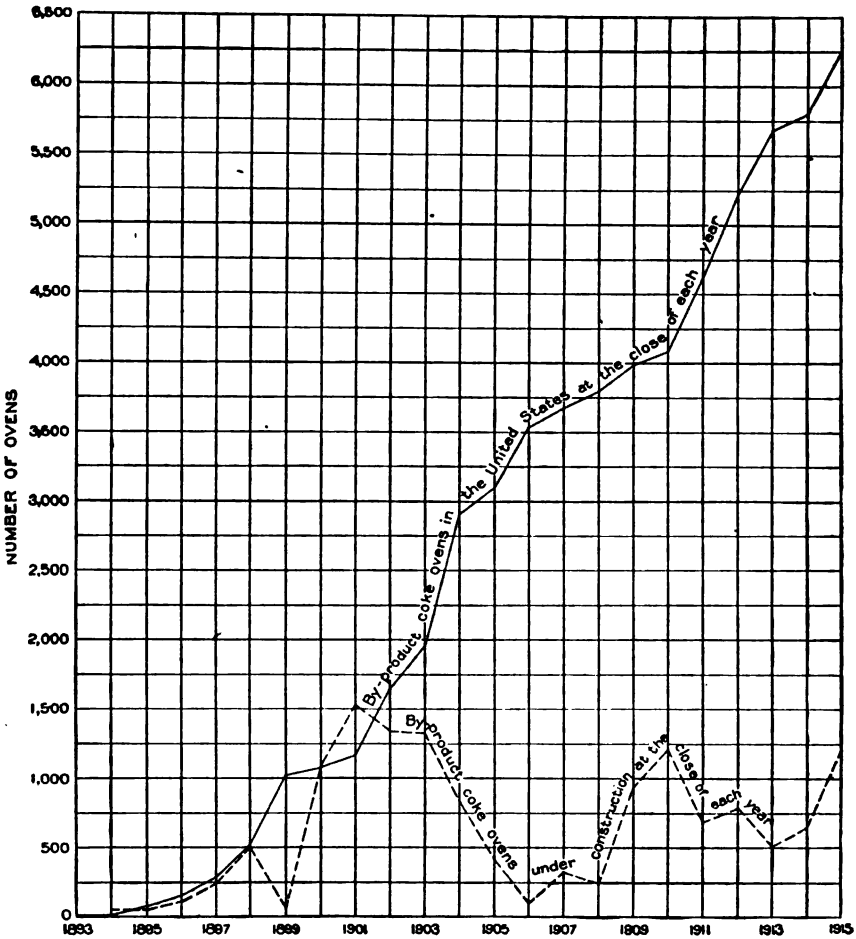

FIGURE 21.—By-product ovens completed and building at the end of each year, 1893–1915.

are entirely obsolete. The history of by-product and beehive oven construction in the United States is shown graphically in figures 21 and 22 and by the tables on the following pages. The reports to the United States Geological Survey by the operators cover the number of ovens in existence and building at the end of each year and the number abandoned during the year. Ovens may be completely

[1] With beehive ovens are included the rectangular ovens and all modified types in which partial combustion of the coal takes place and no by-products are saved.

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constructed during the 12-month period, or they may be abandoned, and the total shown for any year does not therefore necessarily represent the total of those in existence at the end of the previous year plus the number reported building. Some beehive ovens in Kansas, Montana, Oklahoma, and Wisconsin have been idle for many years, but they are reported to the Geological Survey as idle, not as abandoned. In all probability, however, few of these ovens will ever be operated again.

The first by-product ovens were constructed in the United States in 1893 and since 1894 not a year has passed without additions to the number in operation. The number of ovens under construction and the total built at the end of each year are shown graphically in figure 21, and it is interesting to compare the curves with that in figure 19 showing the annual output from these ovens for the same period. The greatest activity in construction was in the years 1901 and 1910. In 1900 there were 1,096 ovens building, 80 of which were completed in 1901. In 1901 there were 1,533 ovens, including 1,005 reported in 1900, under construction, 502 of which were put in operation in 1902. This activity was mainly in Alabama, Maryland, New York, and Pennsylvania, and the majority of the ovens built at this time were of the Otto-Hoffmann or modified types. Between 1903 and 1909 there was a lull in the construction of by-product ovens. In 1909 large installations of Koppers ovens at Gary, Ind., and of Didier ovens at South Bethlehem, Pa., were begun but not completed in 1910; they are, therefore, shown as building in the record for that year also. The number of by-product ovens in course of erection on December 31, 1915, was 1,191, about the same as at the end of 1910. The number of completed ovens has increased at a rapid rate, the only period in which progress was slow having been in the years 1906 to 1910.

Figure 22 shows the number of completed beehive ovens at the end of each year for the period 1880–1915. The number of beehive ovens under construction at the end of each year are also shown, but it is evident that this record is a very poor index of activity; for, as has been previously noted, beehive ovens are constructed in a comparatively short time (and abandoned with equal facility), and an annual statement of those in process of erection furnishes little real information.

From 1880 to 1893 steady progress was made in the erection of beehive ovens, compared with the period from 1894 to 1899, when there were but few additions. From 1900 to 1907, years of great industrial expansion, particularly in the iron and steel business, the number of beehive ovens increased rapidly, and in 1910 the highest point in respect of number of ovens was reached, the same year, it will be noted, that recorded a large number of by-product ovens under construction. Each succeeding year since 1910 has shown a decrease in beehive ovens, and there is no reason to expect otherwise, in view of the present activity in by-product oven construction, than that the trend will continue downward. Data are not available from which a curve could be constructed showing, in connection with the number of beehive ovens in existence, the number of those active, but the appearance of such a curve may be inferred from the line in figure 19 representing the output of beehive coke.

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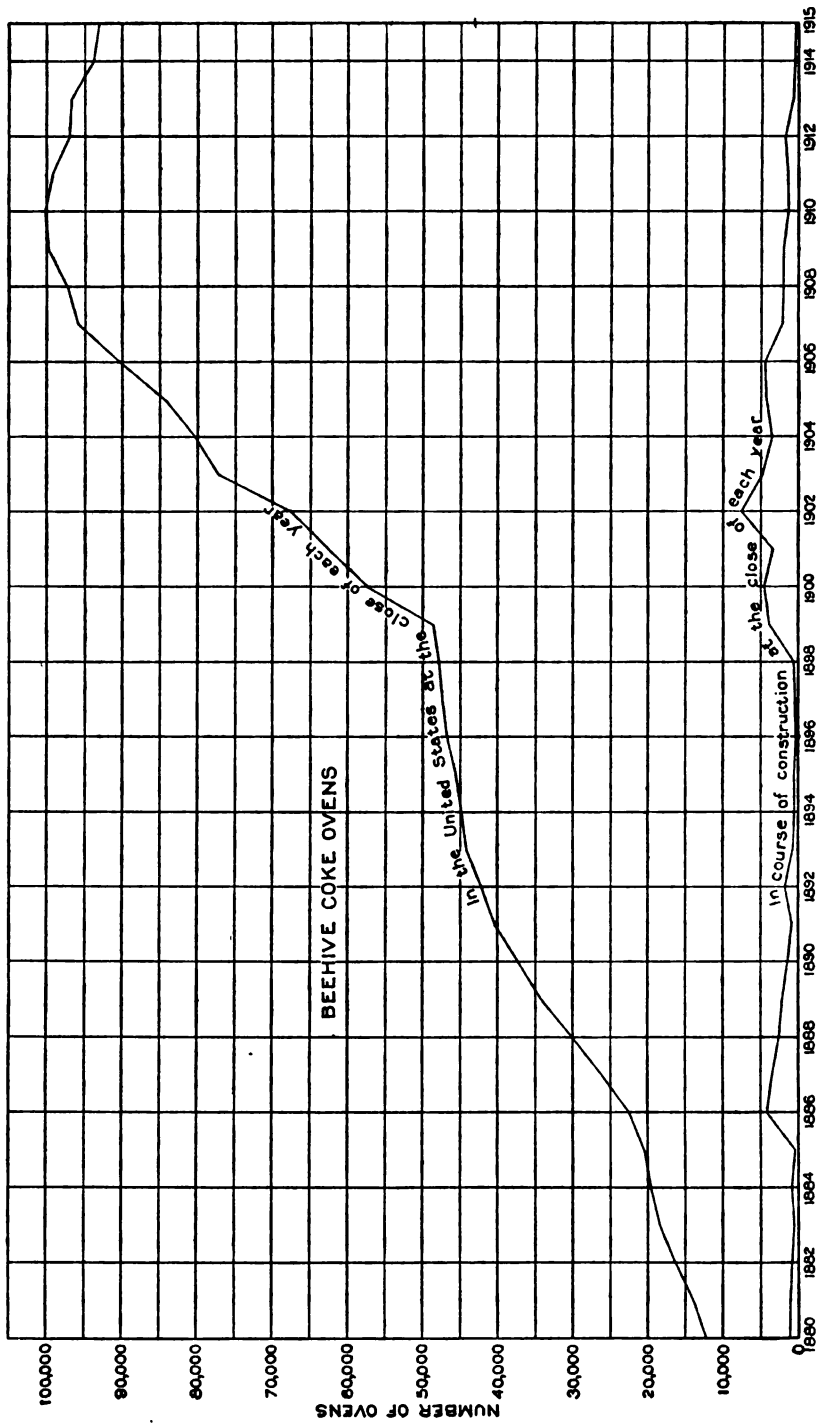

FIGURE 22.—Beehive coke ovens completed and building in the United States at the end of each year, 1880–1915.

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Coke ovens in the United States, 1914 and 1915.

1914.

State.	Active.		Idle.		Total.		Abandoned.		Building at end of year.	
	Bee-hive.	By-product.	Bee-hive.	By-product.	Bee-hive.	By-product.	Bee-hive.	By-product.	Bee-hive.	By-product.
Alabama	2,562	750	5,973	.....	8,535	750	1,049	.....	.....	.....
Colorado	1,431	.....	2,142	.....	3,573	.....	15	.....	.....	.....
Georgia	100	.....	101	.....	201	.....	50	.....	.....	.....
Illinois	.....	546	.....	40	.....	586	.....	.....	.....	40
Indiana	.....	767	.....	[a] 22	.....	789	.....	1	.....	33
Kansas	.....	.....	2	.....	2	.....	.....	.....	.....	.....
Kentucky	487	54	610	.....	1,097	54	6	.....	.....	.....
Maryland	.....	60	.....	[a] 60	.....	120	.....	.....	.....	.....
Massachusetts	.....	400	.....	.....	.....	400	.....	.....	.....	.....
Michigan	.....	205	.....	.....	.....	205	.....	.....	.....	.....
Minnesota	.....	50	.....	[a] 90	.....	140	.....	.....	.....	90
Missouri	.....	.....	.....	.....	.....	.....	.....	.....	.....	56
Montana	.....	.....	351	.....	351	.....	.....	.....	.....	.....
New Jersey	.....	150	.....	.....	.....	150	.....	.....	.....	.....
New Mexico	980	.....	50	.....	1,030	.....	.....	.....	.....	.....
New York	.....	367	.....	188	.....	555	.....	.....	.....	100
Ohio	211	217	110	.....	321	217	1	.....	.....	51
Oklahoma	.....	.....	260	.....	260	.....	.....	.....	.....	.....
Pennsylvania	34,457	1,255	[b] 18,096	267	52,553	1,522	1,237	70	605	262
Tennessee	911	.....	1,392	.....	2,303	.....	125	.....	.....	12
Utah	726	.....	.....	.....	726	.....	.....	.....	.....	.....
Virginia	2,191	.....	3,244	.....	5,435	.....	260	.....	.....	.....
Washington	241	5	90	.....	331	5	.....	.....	.....	.....
West Virginia	5,199	120	[c] 11,801	.....	17,000	120	861	.....	.....	.....
Wisconsin	.....	196	228	.....	228	196	.....	.....	.....	.....
	49,496	5,142	44,450	667	93,946	5,809	3,604	71	605	644

1915.

Alabama	2,506	732	6,062	18	8,568	750	.....	.....	.....	.....
Colorado	1,334	.....	2,239	.....	3,573	.....	.....	.....	.....	.....
Georgia	62	.....	139	.....	201	.....	.....	.....	.....	.....
Illinois	.....	626	.....	.....	.....	626	.....	.....	.....	.....
Indiana	.....	787	.....	[d] 25	.....	812	.....	.....	.....	30
Kansas	.....	.....	2	.....	2	.....	.....	.....	.....	.....
Kentucky	733	54	364	.....	1,097	54	.....	.....	.....	54
Maryland	.....	120	.....	.....	.....	120	.....	.....	.....	.....
Massachusetts	.....	400	.....	.....	.....	400	.....	.....	.....	.....
Michigan	.....	205	.....	.....	.....	205	.....	.....	.....	24
Minnesota	.....	120	.....	.....	.....	120	.....	.....	.....	20
Missouri	.....	56	.....	.....	.....	56	.....	.....	.....	.....
Montana	.....	.....	112	.....	112	.....	239	.....	.....	.....
New Jersey	.....	150	.....	.....	.....	150	.....	.....	.....	.....
New Mexico	600	.....	430	.....	1,030	.....	.....	.....	.....	.....
New York	.....	555	.....	.....	.....	555	.....	.....	.....	100
Ohio	200	250	121	93	321	343	.....	.....	.....	657
Oklahoma	.....	.....	50	.....	50	.....	.....	.....	.....	.....
Pennsylvania	35,984	1,594	[e] 17,128	150	53,112	1,744	189	.....	540	212
Tennessee	805	12	1,497	.....	2,302	12	1	.....	.....	.....
Utah	726	.....	.....	.....	726	.....	.....	.....	.....	.....
Virginia	1,516	.....	3,713	.....	5,229	.....	300	.....	17	.....
Washington	249	5	82	.....	331	5	.....	.....	.....	.....
West Virginia	4,270	120	11,958	.....	16,228	120	834	.....	.....	94
Wisconsin	.....	196	228	.....	228	196	.....	.....	.....	.....
	48,985	5,982	44,125	286	93,110	6,268	1,563	.....	557	1,191

[a] New ovens, built but not operated.
[b] Includes 176 new ovens, built but not operated.
[c] Includes 35 new ovens, built but not operated.
[d] New ovens, built but not yet in operation.
[e] Includes 34 new ovens, built but not yet in operation.

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Beehive coke ovens at end of each year, 1911–1915.

State.	1911	1912	1913	1914	1915
Alabama	9,781	9,588	9,584	8,535	8,568
Colorado	3,606	3,588	3,588	3,573	3,573
Georgia	225	251	251	201	201
Illinois	26	26	.....	.....	.....
Indiana	46	10	.....	.....	.....
Kansas	53	3	2	2	2
Kentucky	577	1,049	995	1,097	1,097
Montana	451	451	351	351	112
New Mexico	1,030	1,030	1,030	1,030	1,030
Ohio	322	322	322	321	321
Oklahoma	410	260	260	260	50
Pennsylvania	53,612	52,314	53,466	52,553	53,112
Tennessee	2,547	2,584	2,427	2,303	2,302
Utah	854	650	726	726	726
Virginia	5,496	5,408	5,695	5,435	5,229
Washington	235	313	331	331	331
West Virginia	19,756	18,944	17,706	17,000	16,228
Wisconsin	228	228	228	228	228
	99,255	97,019	96,962	93,946	93,110

By-product ovens at end of each year, 1911–1915.

State.	1911		1912		1913		1914		1915	
	Built.	Building.	Built.	Building.	Built.	Building.	Built.	Building.	Built.	Building.
Alabama	340	280	620	100	700	20	750	.....	750	.....
Illinois	480	48	568	40	568	58	586	40	626	.....
Indiana	540	70	632	169	749	41	789	33	812	30
Kentucky	.....	.....	.....	41	54	.....	54	.....	54	54
Maryland	200	.....	200	6	[a] 0	120	120	.....	120	.....
Massachusetts	400	.....	400	.....	400	.....	400	.....	400	.....
Michigan	162	.....	165	40	205	.....	205	.....	205	24
Minnesota	50	.....	50	92	50	90	140	90	120	20
Missouri	150	.....	.....	.....	.....	56	.....	56	56	.....
New Jersey	.....	.....	150	.....	150	.....	150	.....	150	.....
New York	556	.....	555	.....	555	.....	555	100	555	100
Ohio	174	.....	149	119	149	119	217	51	343	657
Pennsylvania	1,292	300	1,442	150	1,592	.....	1,522	262	1,744	212
Tennessee	.....	.....	.....	.....	.....	.....	.....	12	12	.....
Washington	.....	.....	.....	.....	.....	.....	5	.....	5	.....
West Virginia	120	.....	120	.....	120	.....	120	.....	120	94
Wisconsin	160	.....	160	36	196	.....	196	.....	196	.....
	4,624	698	5,211	793	[a] 5,488	504	5,809	644	6,268	1,191

[a] At the close of 1913 the 200 ovens at Sparrows Point works of the Maryland Steel Co. that were operated during the year were being torn down to be replaced by 120 ovens of larger dimensions.

The location of the ovens, both idle and active, recorded in the preceding tables, is shown on the map (Pl. IV).

The number of by-product ovens of the different types completed and building in each State at the end of 1915 is given in the following tables:

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By-product ovens in the United States at the end of 1915.

State.	Koppers.	United-Otto.[a]	Semet-Solvay.	Rothberg.	Didier.	Gas machinery.	Klönne.	Wilputte.	Roberts flueless.	Total.
Alabama	450		300							750
Illinois	315		293					18		626
Indiana	646	100	41			3	22			812
Kentucky			54							54
Maryland	120									120
Massachusetts		400								400
Michigan		30	175							205
Minnesota	70	50								120
Missouri	56									56
New Jersey		150								150
New York		188	86	281						555
Ohio	143	100	100							343
Pennsylvania	304	903	360		150	27				1,744
Tennessee									12	12
Washington							5			5
West Virginia			120							120
Wisconsin		36	160							196
	2,104	1,957	1,689	281	150	30	27	18	12	6,268

[a] Includes the Otto-Hoffmann and Schniewind types.

By-product ovens under construction in the United States at the end of 1915.

State.	Koppers.	United-Otto.	Semet-Solvay.	Gas machinery.	Roberts flueless.	Total.
Indiana				30		30
Kentucky			54			54
Michigan		24				24
Minnesota	20					20
New York		100				100
Ohio	633				24	657
Pennsylvania	212					212
West Virginia	94					94
	959	124	54	30	24	1,191

A list of the by-product plants, with notes regarding types of ovens, dates of installation, and uses of by-products, is given in the following table. Similar data for ovens under construction at the end of 1915 are also given in another table. Although used primarily as a source of coke for iron-furnace operations and for the most part built by the iron-producing interests, it will be noted that a number of plants have been installed, with the main purpose of producing gas for municipalities, 13 out of 44 installations being of that character. These 13 plants had 2.266 of the total 6,268 by-product ovens in 1915.

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By-product coke-oven plants in the United States in 1915.

State.	Town.	Name of company owning plant.	Number of ovens.	Type of oven.	Year put in blast.[a]	Uses of coke.	Uses of surplus gas.	Benzol-recovery plant.	Remarks.
Alabama	Ensley	Tennessee Coal, Iron & R. R. Co.	240	Semet-Solvay	1898–1902	Blast furnace	Boiler fuel	Yes	
	Fairfield	do	280	Koppers	1912	Furnace and foundry.	Boiler fuel and open hearth furnace.	Yes	
	Tuscaloosa	Central Iron & Coal Co.	60	Semet-Solvay	1906–1914	do	Boiler fuel	Yes	
	Woodward	Woodward Iron Co	170	Koppers	1911–1914	Blast furnace	Fuel	Yes	
Illinois	Joliet	Coal Products Manufacturing Co.	18	Wilputte	1914	Furnace and foundry.	Illumination, domestic, and industrial fuel.	No	
	do	do	35	Koppers	1912				
	do	Illinois Steel Co	280	do	1908–9	Furnace	Domestic fuel	No	
	South Chicago	By-Products Coke Corporation.	280	Semet-Solvay	1905–1915	Furnace, foundry, and domestic.	Boiler fuel	Yes	
	Waukegan	North Shore Gas Co	13	do	1912	Domestic	Illumination and domestic fuel.	No	
Indiana	Gary	Illinois Steel Co	560	Koppers	1911–12	Furnace	Domestic fuel	Yes	
	Indiana Harbor	Inland Steel Co	86	do	1913–1915	do	Industrial, fuel, and steam.	Yes	
	Indianapolis	Citizens Gas Co	100	United-Otto	1909–1913	Furnace and foundry.	Illumination, domestic, and industrial fuel.	Yes	Leased to Citizens Gas Co.
	do	Indianapolis Gas Co	41	Semet-Solvay	1914				
	Linton	Linton Gas Co	3	Gas Machinery					Built, 1915, but not yet operated.
	Muncie	Central Indiana Gas Co	22	Klönne					Built, 1912, but not yet operated.
Kentucky	Ashland	Kentucky Solvay Co	54	Semet-Solvay	1913	Blast furnace, domestic and foundry.	Boiler fuel	Yes	Doubling size of plant.
Maryland	Sparrows Point	Maryland Steel Co	120	Koppers	1914	Blast furnace	Illumination and fuel	Yes	Originally 200 United Otto ovens; torn down, 1913, and Koppers ovens substituted.
Massachusetts	Everett	New England Gas & Coke Co.	400	Otto-Hoffmann	1899	Foundry and domestic.	Illumination	Yes	
Michigan	Detroit	Solvay Process Co	175	Semet-Solvay	1901–1913	Furnace, foundry, and domestic.	Illumination and boiler fuel.	Yes	
	Wyandotte	Michigan Alkali Co	30	Otto-Hoffmann	1902–1906	Furnace and domestic.	Fuel	No	
Minnesota	Duluth	Minnesota Steel Co	70	Koppers	1915	Furnace	do	No	Completed, 1914, but not in blast until 1915
	West Duluth	Zenith Furnace Co	50	United-Otto	1904	do	Illumination	Yes	

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Missouri	St. Louis	Laclede Gas Light Co.	56	Koppers	1915	Foundry and domestic.	Illumination, domestic, and industrial fuel.	Yes	
New Jersey	Camden	Camden Coke Co.	150	Otto-Hoffmann	1903–1906	Furnace and domestic.	Illumination and fuel	No	First to install enrichment by benzol transfer.
New York	Geneva	Empire Coke Co.	46	Semet-Solvay	1904–1909	Foundry and domestic.	Illumination and gas-engine fuel.	Yes	
	Lackawanna	Lackawanna Steel Co.	188	Otto-Hoffmann	1904	Furnace	Fuel	Yes	
	do	do	281	Rothberg					
	Solvay	Solvay Process Co.	40	Semet-Solvay	1893–1903	Foundry and domestic.	Boiler fuel	Yes	First by-product plant in United States. Main purpose originally to obtain ammonia for alkali works.
Ohio	Hamilton	Hamilton-Otto Coke Co.	100	Otto-Hoffmann	1901–1909	Furnace	Illumination, domestic, and industrial fuel.	No	Gas purchased and distributed by Hamilton Utilities Co.
	Cleveland	Cleveland Furnace Co.	100	Semet-Solvay	1910–1915	Furnace and domestic.	Illumination and boiler fuel.	Yes	49 of these originally 80 Rothberg ovens.
	Youngstown	Republic Iron & Steel Co.	143	Koppers	1914–15	Furnace	Fuel	Yes	
Pennsylvania	Chester	The Philadelphia Suburban Gas & Electric Co.	40	Semet-Solvay	1904	do	Illumination, domestic, and industrial fuel.	Yes	Coke-oven gas mixed with water gas before being sold.
	Dunbar	Dunbar Furnace Co. and American Manganese Mfg. Co.	110	do	1896–1908	Furnace, foundry, and domestic.	Fuel	Yes	
	Farrell	Carnegie Steel Co.	212	United-Otto	1908	Furnace	do	Yes	
	Glassport	Allegheny By-Products Coke Co.	120	Otto-Hoffmann	1907	Furnace, foundry, and domestic.	do	Yes	
	Johnstown	Cambria Steel Co.	92	Koppers	1915	Furnace	do	Yes	Originally United-Otto ovens.
	do	do	27	Gas Machinery	1914				
	do	do	343	United-Otto	1895–1907				
	Lebanon	Lackawanna Iron & Steel Co.	228	do	1903	do		Yes	
	do	Pennsylvania Steel Co.	90	Semet-Solvay	1904	Blast furnace	Boiler fuel	Yes	
	South Bethlehem	Lehigh Coke Co.	150	Didier	1912–13	Furnace and foundry.	Fuel	No	Originally 300 ovens; 150 replaced by Koppers ovens.
	do	do	212	Koppers	1915				
	Steelton	Pennsylvania Steel Co.	120	Semet-Solvay	1907	Furnace	Illumination and boiler fuel.	Yes	
Tennessee	Chattanooga	Chattanooga Gas & Coal Products Co.	12	Roberts flueless	1915	Furnace and foundry.	Illumination	No	Gas sold to Chattanooga Gas Co.
Washington	Seattle	Seattle Lighting Co.	5	Klönne	1914	Furnace, foundry, and domestic.	Illumination, domestic, and industrial fuel.	No	Gas mixed with other gases when sold; supplies Seattle and suburbs.

[a] The first and last years are given for those plants that have two or more installations.

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By-product coke-oven plants in the United States in 1915—Continued.

State.	Town.	Name of company owning plant.	Number of ovens.	Type of oven.	Year put in blast.	Uses of coke.	Uses of surplus gas.	Benzol-recovery plant.	Remarks.
West Virginia	Benwood	National Tube Co.	120	Semet-Solvay	1898–1901	Furnace	Boiler fuel	Yes	
Wisconsin	Mayville	Northwestern Iron Co.	36	Otto-Hoffmann	1914	Furnace and domestic.	Fuel	Yes	
	Milwaukee	Milwaukee Coke & Gas Co.	160	Semet-Solvay	1904–1906	Furnace, foundry, and domestic.	Illumination, domestic, and boiler fuel.	Yes	Gas sold to Milwaukee Gas Light Co.

By-product ovens under construction in the United States on January 1, 1916.

State.	Town.	Name of company owning plant.	Number of ovens.	Type of oven.	Benzol-recovery plant.	Remarks.
Indiana	Terre Haute	Indiana Coke & Gas Co.	30	Gas Machinery		Operations to begin August, 1916.
Kentucky	Ashland	Kentucky Solvay Coke Co.	54	Semet-Solvay	Yes	Doubling capacity of plant.
Michigan	Wyandotte	Michigan Alkali Co.	24	Otto-Hoffmann	No	Increasing size of plant; 30 ovens already in operation.
Minnesota	Duluth	Minnesota Steel Co.	20	Koppers		Increasing size of plant; 70 Koppers in operation for the first time in 1915.
New York	Lackawanna	Niagara Coke Corporation	100	Otto Regenerative		Began construction in 1914.
Ohio	Canal Dover	Dover By-Products Coke Co.	24	Roberts flueless	Yes	Began construction October, 1915.
	Canton	United Furnace Co.	47	Koppers	Yes	
	Coitsville	Youngstown Sheet & Tube Co.	204	do	Yes	
	Cleveland	River Furnace Co.	204	do	Yes	
	Toledo	Toledo Furnace Co.	94	do	Yes	Began operations May, 1916.
	Youngstown	Brier Hill Steel Co.	84	do	Yes	
Pennsylvania	South Bethlehem	Lehigh Coke Co.	212	do	Yes	Doubling capacity of plant; began operations April, 1916.
West Virginia	Follansbee	LaBelle Iron Works	94	do	Yes	

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VALUE OF COKE PRODUCED.

A considerable proportion of the coke produced in the United States is made in ovens or retorts operated by large corporations that not only mine the coal and make the coke but also operate blast furnaces and steel mills, which consume the entire product of the ovens. Under such conditions the fixing of a value upon the coke and upon the coal consumed in its making is purely arbitrary. By some corporations the coke is charged to the furnace department at cost; by others a percentage of profit is added, or the reported value is based on what it would cost if purchased. As the beehive ovens are replaced by the retorts the proportion of the coke upon which the arbitrary values are fixed will increase, because the retort ovens are for the most part constructed by or for furnace operators and the product of the ovens does not go to the general markets. It must not be considered, therefore, that the values as stated in this and other reports of the series represent the actual selling value of all the coke, but they are sufficiently exact for statistical comparison.

The average value per ton for by-product coke in 1915 was $3.45, compared with $3.39 in 1914, and for beehive was $2.07, as against $2.15 in 1914. As explained in previous reports, the higher value of retort coke is due not to the superior quality of that product but to the fact that the by-product ovens are located considerable distances from the coal mines and at or near the centers of consumption, where markets for the gas and other by-products as well as for the coke are available. Hence, the expenses of transportation are borne by the coal and are added to the value of the coal as charged into the ovens and an equivalent value is necessarily added to the coke. The beehive and similar types of ovens are, on the other hand, in the immediate vicinity of the mines and the expenses of transportation are borne by the coke, and the beehive coke thus costs the ultimate consumer as much as the apparently higher-valued retort coke.

In the following tables are presented statements showing the value of the coke at the ovens in the several States for the years 1911 to 1915, with the quantity and percentage of increase or decrease in 1915 compared with 1914, the average value per ton by States for the same years, as well as a comparison of the average values of beehive and by-product coke for the years 1908 to 1915. These averages are not the averages of the prices themselves, but are obtained by dividing the total quantity of coke produced into the total value in each State, with the same method for the total for the United States. The figures represent closely, therefore, the average values obtained by the producers. As has already been explained, the values of the product reported to the Survey do not always represent actual cash or its equivalent received by the producers, as some of the largest operations are carried on in connection with blast furnaces or other manufacturing enterprises and the placing of value upon their coke by such producers is arbitrary. As the same methods of valuation at any one point are, however, employed each year, they would not affect materially the changes due to market conditions, and the statement of value per ton may be accepted as indicating closely the relations of supply and demand.

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Value, at the ovens, of the coke made in the United States, 1912–1915.

State.	1912	1913	1914	1915	Increase or decrease, 1915.			
					Value.	Percentage.		
						Total.	Beehive.	By-product.
Alabama	$8,098,412	$9,627,170	$8,408,443	$8,545,555	+ $137,112	+ 1.6	− 7.3	+ 7.5
Colorado	3,043,994	2,815,134	2,203,081	2,242,453	+ 39,422	+ 1.8	+ 1.8	0
Georgia	161,842	186,304	100,529	81,170	− 19,359	− 19.3	−19.3	0
Illinois	8,069,903	8,593,581	5,858,700	7,016,635	+ 1,157,935	+ 19.8	0	+ 19.8
Indiana	12,528,685	13,182,136	9,055,937	11,604,588	+ 2,548,651	+ 28.1	0	+ 28.1
Kansas	(a)	0	0	0	0	0	0	0
Kentucky	513,734	753,897	971,060	1,129,769	+ 158,709	+ 46.3	+12.4	+ 20.2
Maryland	(a)	(a)	299,739	762,664	+ 462,925	+154.4	0	+154.4
Massachusetts	(a)	(a)	(a)	(a)	(a)	− 3.2	0	− 3.2
Michigan	(a)	(a)	(a)	(a)	(a)	+ 22.5	0	+ 22.5
Minnesota	(a)	(a)	(a)	475,952	(a)	.....	0	.....
Missouri	0	0	0	(a)	(a)	.....	0	.....
New Jersey	690,368	695,041	(a)	(a)	(a)	.....	0	.....
New Mexico	1,356,946	1,548,536	1,228,045	1,265,268	+ 37,223	+ 3.0	+ 3.0	0
New York	3,203,133	3,301,400	1,726,133	2,459,463	+ 733,330	+ 42.5	0	+ 42.5
Ohio	1,365,905	1,231,554	1,678,686	2,136,933	+ 458,247	+ 27.3	−70.9	+ 41.7
Pennsylvania	56,336,255	67,929,864	42,447,886	52,667,018	+10,219,132	+ 24.1	+20.7	+ 42.5
Tennessee	951,853	925,430	642,573	674,014	+ 31,441	+ 4.9	− 4.9	0
Utah	(a)	(a)	(a)	(a)	(a)	+ 11.2	+11.2	0
Virginia	1,815,975	2,840,275	1,582,419	1,242,938	− 339,481	− 21.5	−21.5	0
Washington	279,105	432,770	472,531	700,832	+ 228,301	+ 48.3	+25.3	+334.2
West Virginia	4,692,393	5,504,416	2,847,284	2,760,805	− 86,479	− 3.0	−13.2	+191.8
Wisconsin	(a)	(a)	(a)	(a)	(a)	− .2	0	− .2
Combined States	8,696,610	9,354,765	8,811,221	9,737,811	+ 1,402,542	.....	.....	.....
	111,805,113	128,922,273	88,334,217	105,503,868	+17,169,651	+ 19.4	+13.3	+ 27.5

[a] Included in combined States.

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Average value per short ton, at the ovens, of the coke made in the United States, 1911–1915.

State.	1911	1912	1913	1914	1915
Alabama	$2.75	$2.72	$2.90	$2.73	$2.78
Colorado	3.30	3.13	3.20	3.30	3.34
Georgia	3.60	3.75	4.35	4.10	4.05
Illinois	3.97	4.57	4.62	4.11	4.16
Indiana	(a)	4.79	4.83	3.98	4.19
Kentucky	2.04	2.68	2.38	2.19	2.15
Maryland	(a)	(a)	(a)	(a)	2.43
Minnesota	(a)	(a)	(a)	(a)	3.72
New Jersey	(a)	2.55	2.72	2.67	(a)
New Mexico	3.25	3.28	3.31	3.39	3.25
New York	4.20	4.03	4.35	3.77	3.72
Ohio	3.09	3.51	3.50	3.21	3.12
Pennsylvania	1.96	2.05	2.36	2.10	2.06
Tennessee	2.41	2.57	2.50	2.43	2.62
Virginia	1.77	1.88	2.18	2.02	1.97
Washington	5.38	5.67	5.68	5.56	5.13
West Virginia	1.85	1.90	2.23	1.99	1.98
Other States	3.75	3.71	3.99	3.79	3.75
Average	2.37	2.54	2.78	2.56	2.54

a Included in other States having less than 3 producers.

Average values of beehive and by-product coke, 1908–1915, per net ton.

Year.	Beehive.	By-product.	Mean average.	Year.	Beehive.	By-product.	Mean average.
1908	$2.20	$3.44	$2.40	1912	$2.10	$3.84	$2.54
1909	2.10	3.27	2.29	1913	2.39	3.82	2.78
1910	2.17	3.47	2.39	1914	2.15	3.39	2.56
1911	2.05	3.48	2.37	1915	2.07	3.45	2.54

PRICES IN THE CONNELLSVILLE REGION.

The most active coke market is in the Connellsville region of Pennsylvania, and as the prices for the product from that district govern largely those in other places the following table is given showing prices during the years 1913, 1914, and 1915. These prices are the quotations given in the current issues of the Iron Age, and are for Connellsville coke at the ovens. The spot prices are for immediate delivery and the contract prices, as the term implies, are those established to cover the requirements of the buyer for a period usually of six months' duration. The relation of supply to demand governs to a large extent, of course, the range of prices for both spot and contract coke. When demand is strong and a shortage of supplies is felt, as in the early months of 1913 or the late months of 1915, the prices for spot coke were above contract prices. In other times contract prices are usually higher. The greater part of the coke in this region changes hands on the contract basis and the prices are steadier and do not show the wide range noted in spot prices. In 1915 prices for both furnace and foundry coke ranged higher than in 1914, but were below the maximum of 1913. Prices for furnace coke were steady during the first half of 1915 and did not show much improvement until October. The car shortage in November and December caused a sudden and sharp increase in the prices for spot coke.

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Prices of Connellsville furnace and foundry coke per net ton at the ovens, 1913–1915.

Month.	Furnace.					
	1913		1914		1915	
	Spot.	Contract.	Spot.	Contract.	Spot.	Contract.
January	$3.50 to $4.15	$3.15 to $3.25	$1.85	$2.00	$1.50 to $1.60	$1.65 to $1.75
February	2.25 to 3.00	2.50 to 3.00	1.85	2.00	1.50 to 1.60	1.65 to 1.75
March	2.30 to 2.40	2.50	$1.85 to 2.00	2.00	1.50 to 1.60	1.65 to 1.75
April	2.00 to 2.25	2.25	1.85 to 1.90	2.00	1.50 to 1.60	1.65 to 1.75
May	2.00 to 2.20	2.25	1.75 to 1.85	$1.90 to 2.00	1.50 to 1.60	1.65 to 1.75
June	2.10 to 2.15	2.25	1.75	1.85 to 1.90	1.50 to 1.60	1.65 to 1.75
July	2.25 to 2.50	2.25 to 2.50	1.75	1.85 to 1.90	1.55 to 1.75	1.70 to 1.85
August	2.50	2.50	1.70	1.75 to 1.85	1.50 to 1.60	1.75 to 1.85
September	2.15 to 2.50	2.25 to 2.50	1.60 to 1.70	1.75	1.50 to 1.75	1.75 to 1.85
October	2.00 to 2.15	2.10 to 2.25	1.60	1.75	1.75 to 2.60	2.25 to 2.40
November	1.75 to 1.90	1.90 to 2.00	1.50 to 1.60	1.75	2.10 to 2.50	2.25 to 2.50
December	1.75	1.80 to 1.85	1.50	1.75	2.10 to 3.50	2.40 to 2.50

Month.	Foundry.					
	1913		1914		1915	
	Spot.	Contract.	Spot.	Contract.	Spot.	Contract.
January	$4.25 to $4.50	$3.60 to $4.00	$2.50	$2.60	$2.00	$2.15 to $2.25
February	3.00 to 3.50	3.00 to 3.50	2.50	$2.60 to 2.75	2.00	2.15 to 2.50
March	3.00	3.00	$2.40 to 2.50	2.65 to 2.75	2.00	2.15 to 2.50
April	3.00	3.00	2.40	2.50 to 2.55	$2.00 to 2.25	2.15 to 2.39
May	2.75 to 3.00	2.90 to 3.00	2.40	2.50	1.90 to 2.25	2.15 to 2.50
June	2.75 to 2.85	3.00	2.30 to 2.40	2.50	1.90 to 2.25	2.15 to 2.50
July	2.75	3.00	2.25 to 2.35	2.35 to 2.50	2.00 to 2.25	2.25 to 2.50
August	2.90	3.00	2.25	2.35	2.00 to 2.25	2.25 to 2.50
September	2.90	3.00	2.00 to 2.20	2.15 to 2.35	2.00 to 2.25	2.25 to 2.50
October	2.75 to 2.90	3.00	2.00	2.15	2.15 to 2.75	2.40 to 2.75
November	2.50 to 2.65	2.75	1.90 to 2.00	2.15	2.75 to 3.00	2.60 to 3.25
December	2.50	2.60 to 2.75	1.90	2.15	2.75 to 3.50	3.00 to 3.25

COAL USED IN THE MANUFACTURE OF COKE.

GENERAL STATISTICS.

The following tables show the quantity and value of the coal used in the manufacture of coke in the several States in 1914 and 1915.

The quantity of coal consumed in making coke reported in this chapter each year is at considerable variance with the quantity reported as made into coke in the chapter on the production of coal. The reason for this discrepancy is that in the chapter on the production of coal the quantity made into coke takes into account only that coal which is coked at the mines. The coal shipped to ovens at a distance, which includes nearly all that charged into by-product ovens reported by the coke manufacturers, is included in the shipments and not in the quantity made into coke, reported by the coal operators. To total quantity of coal made into coke in 1915 was 61,832,898 net tons. The coal-mine operators reported 40,595,446 tons made into coke at the mines.

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Coal used in the manufacture of coke in the United States in 1914 and 1915.

1914.

State.	Coal used (net tons).	Total value of coal.	Value of coal per ton.	Quantity of coal per ton of coke (net tons).	Value of coal to a ton of coke.
Alabama	4,678,196	$6,765,639	$1.45	1.517	$2.200
Colorado	1,048,251	1,874,580	1.79	1.574	2.817
Georgia	45,298	82,260	1.82	1.848	3.363
Illinois	1,932,132	5,455,620	2.82	1.356	3.824
Indiana	3,125,207	8,881,590	2.84	1.373	3.899
Kentucky	672,624	864,071	1.28	1.515	1.939
New Jersey	328,921	841,991	2.56	1.288	3.297
New Mexico	660,501	981,046	1.49	1.822	2.715
New York	659,418	1,657,502	2.51	1.442	3.619
Ohio	745,097	1,438,891	1.93	1.428	2.756
Pennsylvania	30,286,961	34,870,144	1.15	1.495	1.719
Tennessee	487,446	506,643	1.04	1.845	1.919
Virginia	1,319,901	1,022,124	.77	1.690	1.301
Washington	133,349	342,621	2.57	1.570	4.035
West Virginia	2,316,309	1,897,912	.81	1.622	1.314
Other States [a]	3,184,139	7,466,931	2.35	1.433	3.368
	51,623,750	74,949,565	1.45	1.494	2.166

1915.

Alabama	4,695,038	6,955,215	1.48	1.529	2.263
Colorado	1,026,019	1,850,551	1.80	1.678	3.020
Georgia	35,377	64,869	1.83	1.765	3.230
Illinois	2,335,933	6,697,209	2.87	1.385	3.975
Indiana	3,685,774	10,830,362	2.94	1.332	3.916
Kentucky	799,847	1,000,721	1.25	1.520	1.900
Maryland	470,326	1,185,926	2.52	1.501	3.783
Massachusetts	666,930	(b)	(b)	1.322	(b)
Minnesota	180,767	490,864	2.72	1.414	3.846
New Mexico	732,830	804,550	1.10	1.882	2.070
New York	975,056	2,435,257	2.50	1.071	2.678
Ohio	985,471	1,853,574	1.88	1.439	2.705
Pennsylvania	38,273,744	43,779,862	1.14	1.494	1.703
Tennessee	465,865	498,256	1.07	1.813	1.940
Virginia	995,396	762,233	.77	1.580	1.217
Washington	204,879	604,867	2.95	1.500	4.425
West Virginia	2,273,763	1,864,315	.82	1.633	1.339
Other States [c]	3,028,383	[d] 8,355,493	[d] 2.26	1.445	[d] 3.211
	61,832,898	90,034,124	1.46	1.487	2.171

[a] Includes Maryland, Massachusetts, Michigan, Minnesota, Utah, and Wisconsin.
[b] Included in other States.
[c] Includes Michigan, Missouri, New Jersey, Utah, and Wisconsin.
[d] Includes also Massachusetts.

Approximately 61,800,000 tons of coal were used in the manufacture of coke in 1915, compared with 51,600,000 tons in 1914. About one-fifth of the coal is washed before being charged into the coke ovens, and the refuse from the washeries is excluded in these statistics. The total value of the coal was $90,000,000, or an average per ton of $1.46, in 1915, as against $75,000,000, or an average of $1.45 in 1914. There was a slight gain in the yield of coke from coal; an average of 1.487 tons of coal were required per ton of coke in 1915, compared with 1.494 tons in 1914. The difference between the total value (equivalent to cost) of the coal used and the coke produced in 1914 was $13,384,000, or an average of 39 cents per ton of coke; in 1915 the figures were $15,470,000, or an average of 37 cents for each ton of coke.

Most of the by-product plants are in the iron-producing centers and at a considerable distance from the coal fields, in fact, by-product

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coke was made in 5 States in 1915, in which there are no coal deposits, and in 4 others in which no high-grade coking coal is found. It is the usual practice to use a mixture of coals in by-product ovens, and a favorite combination seems to be high volatile or "gas" coal from eastern Kentucky, the Kanawha or Fairmont district of West Virginia, or southwestern Pennsylvania, with low volatile or "smokeless" coal from the Pocahontas and New River fields of West Virginia or from central Pennsylvania. It thus happens that a large part of the coal used comes from the mines in West Vriginia (in 1913 44 per cent was from that State), and in 1915 West Virginia coal was used at places as far distant as Illinois, Indiana, Wisconsin, and Minnesota. The total quantity of coal used in the manufacture of by-product coke in each State in 1915 and the States from which it came are shown in the following table. Data regarding the respective quantities from each State are not available. Practically all the coal charged into beehive ovens comes from mines immediately adjacent to the ovens, or at no great distance, and the coal used in the manufacture of beehive coke may be considered to have its source in the same State as the beehive coke.

Source of coal used in the manufacture of by-product coke in 1915.

State in which coke was made.	Coal used (net tons).	States from which coal was obtained.
Alabama	2,987,710	Alabama.
Illinois	2,335,933	West Virginia mainly; remainder from Illinois, Kentucky, and Pennsylvania.
Indiana	3,685,774	West Virginia mainly; remainder from Illinois, Kentucky, and Pennsylvania.
Kentucky	337,679	West Virginia and Kentucky.
Maryland	470,326	West Virginia, Pennsylvania, and Maryland.
Massachusetts	666,930	Canada, Virginia, and West Virginia.
Michigan	(a)	West Virginia, Pennsylvania, and Kentucky.
Minnesota	180,767	Pennsylvania mainly; remainder from West Virginia.
Missouri	(a)	Kentucky and West Virginia.
New Jersey	(a)	West Virginia.
New York	975,656	Pennsylvania mainly; remainder from West Virginia.
Ohio	956,656	West Virginia, Pennsylvania, and Kentucky.
Pennsylvania	4,301,726	Nearly all from Pennsylvania; small part from West Virginia.
Tennessee	32,084	Tennessee.
Washington	(a)	Washington.
West Virginia	202,762	Pennsylvania 90 per cent; West Virginia 10 per cent.
Wisconsin	(a)	West Virginia.
Other States	2,420,379	
	19,554,382	

a Included in "Other States."

YIELD OF COKE FROM COAL.

The yield of coke from coal—that is, the percentage of coke obtained to the coal used—is higher in by-product ovens than in beehive ovens. It was formerly considered good practice to obtain a yield of from 50 to 60 per cent in beehive ovens and of 70 per cent in by-product ovens. The yield from beehive ovens in 1915 was 65 per cent and from by-product ovens nearly 72 per cent; the average for both was 67 per cent. Only two plants, both beehive, reported yields below 50, and several beehive operations showed records above 75 per cent. Some of the by-product coke ovens had yields above 77 per cent; none was below 67 per cent.

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Percentage yield of coke from coal, 1911–1915.

State.	1911	1912	1913	1914	1915
Alabama	62.6	64.9	63.6	65.9	65.4
Colorado	66.6	66.0	65.1	63.5	65.4
Georgia	51.7	50.0	51.5	54.1	56.6
Illinois	77.1	76.2	74.9	73.8	72.2
Indiana	80.6	81.8	77.1	72.8	75.1
Kansas	70.0	70.0	0	0	0
Kentucky	55.9	62.4	61.9	66.0	65.8
Maryland	66.2	65.8	69.4	67.6	66.7
Massachusetts	77.4	75.5	76.3	76.4	75.6
Michigan	74.2	75.4	76.2	74.1	72.0
Minnesota	67.6	69.6	66.9	68.4	70.7
Missouri	0	0	0	0	77.0
New Jersey	76.2	78.4	75.4	77.6	77.0
New Mexico	61.5	60.9	59.4	54.9	53.1
New York	71.8	72.6	71.1	69.0	70.2
Ohio	68.2	69.2	69.3	70.0	69.5
Pennsylvania	66.7	66.5	66.6	66.9	66.9
Tennessee	52.6	54.0	52.5	54.2	55.2
Utah	59.0	56.8	56.9	.....	.....
Virginia	63.9	62.2	64.7	59.2	63.3
Washington	66.6	62.6	64.2	63.7	66.7
West Virginia	60.4	60.7	61.3	61.6	61.2
Wisconsin	74.9	69.6	76.2	70.8	70.3
Total average	66.7	67.1	66.9	66.9	67.2

CHARACTER OF COAL USED IN MANUFACTURE OF COKE.

More than one-fifth of the coal used in the manufacture of coke in 1915 was washed. Coke for iron furnaces must be as free from ash and sulphur as possible. Dirty coals are therefore cleaned by washing before being charged into the coke ovens, and in 1915 more than 13,000,000 tons of coal, about one-half run-of-mine and one-half slack, were so treated. All of the coal used for making coke in Georgia, New Mexico, Tennessee, and Washington, and more than 95 per cent of that in Alabama and Colorado was washed. In some of the coal fields the slack is screened out and used in making beehive coke and the lump coal is shipped to market. The by-product ovens, however, use run-of-mine of the best quality and practically all the coal made into coke in ovens of that type outside of Alabama was unwashed coal of that character.

Coal used in the manufacture of coke in 1914 and 1915, by kinds, in net tons.

1914.

State.	Run of mine.		Slack.		Total.			
	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Per-centage.	Washed.	Per-centage.
Alabama	703,241	2,069,638	.....	1,905,317	703,241	15.0	3,974,955	85.0
Colorado	193	890,948	13,976	143,134	14,169	1.4	1,034,082	98.6
Georgia	.....	.....	.....	45,298	.....	.....	45,298	100.0
Illinois	1,913,648	.....	18,484	.....	1,932,132	100.0	.....	.....
Indiana	2,926,637	61,014	137,556	.....	3,064,193	98.0	61,014	2.0
Kentucky	632,913	.....	.....	39,711	632,913	94.1	39,711	5.9
New Jersey	328,921	.....	.....	.....	328,921	100.0	.....	.....
New Mexico	.....	.....	249,546	410,955	249,546	37.8	410,955	62.2
New York	503,540	78,499	1,663	75,716	505,203	76.6	154,215	23.4
Ohio	743,549	.....	1,548	.....	745,097	100.0	.....	.....
Pennsylvania	25,568,962	2,135,754	465,927	2,116,318	26,034,889	86.0	4,252,072	14.0
Tennessee	6,499	140,500	.....	340,447	6,499	1.3	480,947	98.7
Virginia	460,164	.....	859,737	.....	1,319,901	100.0	.....	.....
Washington	560	132,789	.....	.....	560	.4	132,789	99.6
West Virginia	537,613	.....	1,554,278	224,418	2,091,891	90.3	224,418	9.7
Other States[a]	2,190,836	6,148	987,155	.....	3,177,991	99.8	6,148	.2
	36,517,276	5,515,290	4,289,870	5,301,314	40,807,146	79.0	10,816,604	21.0

[a] Includes Maryland, Massachusetts, Michigan, Minnesota, Utah, and Wisconsin.

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Coal used in the manufacture of coke in 1914 and 1915, by kinds, in net tons—Contd.

1915.

State.	Run of mine.		Slack.		Total.			
	Unwashed.	Washed.	Unwashed.	Washed.	Unwashed.	Per-centage.	Washed.	Per-centage.
Alabama	158,480	1,522,149	47,061	2,968,248	205,541	4.4	4,490,397	95.6
Colorado	11,519	978,913	3,330	32,257	14,849	1.4	1,011,170	98.6
Georgia				35,377			35,377	100.0
Illinois	2,295,933	40,000			2,295,933	98.3	40,000	1.7
Indiana	3,335,843		349,931		3,685,774	100.0		
Kentucky	738,963		10,871	50,013	749,834	93.7	50,013	6.3
Maryland	470,326				470,326	100.0		
Massachusetts	666,930				666,930	100.0		
Minnesota	45,767		135,000		180,767	100.0		
New Mexico				732,830			732,830	100.0
New York	750,628		2,340	222,688	752,968	77.2	222,688	22.8
Ohio	984,028		1,443		985,471	100.0		
Pennsylvania	32,219,894	3,337,005	442,791	2,274,054	32,662,685	85.3	5,611,059	14.7
Tennessee		156,738		309,127			465,865	100.0
Virginia	198,290		698,998	98,108	897,288	90.1	98,108	9.9
Washington		158,496		46,383			204,879	100.0
West Virginia	478,048	65,120	1,500,389	230,206	1,978,437	87.0	295,326	13.0
Other States [a]	2,279,806		748,577		3,028,383	100.0		
	44,634,455	6,258,421	3,940,731	6,999,291	48,575,186	78.6	13,257,712	21.4

[a] Includes Michigan, Missouri, New Jersey, Utah, and Wisconsin.

BY-PRODUCTS OBTAINED IN MANUFACTURE OF COKE.

The recovery of the valuable by-products from American coke manufacture made big advances in 1915 and has now attained the proportions of an important industry. The value of these by-products was nearly $30,000,000, a large increase over the previous high-water mark of $17,500,000 in 1914. Although there were material increases in the output and value of gas, tar, and ammonia, which was to be expected with a greater output of by-product coke, the increase in benzol products was remarkable and presented the most interesting feature of the year in the coke industry. The value of these products rose from less than $1,000,000 in 1914 to more than $7,760,000 in 1915. Benzol has been recovered in this country from coke-oven gas for a number of years, but prior to 1915 the market was small and the price low.

The awakening of the American people to the need for a dye industry and to a realization that such an industry can not spring full-grown from nothing but must be fostered and developed is now a well-known story. Few are aware, however, of the progress that has been made within a year in laying the foundations for future progress in that industry. Under the spur of almost fabulous prices for benzol products, retort coke-oven plants throughout the country quickly installed elaborate benzol-recovery systems and now save the valuable oils that not very long ago were being burned or wasted or, if saved, were begging for a market.

In 1914 there were 14 benzol plants in the United States, but they were all controlled by one company, and therefore it is not feasible to publish the statistics of their production for that or previous years. Sixteen additional coke plants were equipped with benzol apparatus in 1915, and the output was very greatly increased. The incentive for putting in this equipment was, of course, the opportunity to contract at war prices for benzol and other similar materials for use in making explosives for the European countries. When the demand from that source shall have ceased, the United States will be in possession of a

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large supply of the raw materials from which dyes and chemicals are made and will be able, if trade conditions are right, to enter into the manufacture of these essential materials on an ever-increasing scale. The prompt and successful manner in which, in 1915, under favorable conditions, the producers increased the benzol supply and entered the field of manufacturing dyes on a larger scale than ever before demonstrates the fact that in this country technical ability and business courage are not lacking and promises well for the future progress of the industry.

The benzol products obtained in 1915 amounted to 16,600,657 gallons. More than 13,000,000 gallons of the total output was reported as crude light oil and had an average value of 33 cents. Some of the plants have their own stills and refineries, and the pure benzol reported from those sources amounted to 2,516,483 gallons, with an average value of nearly 57 cents, at least three times the value of crude benzol before the war, and 623,506 gallons of toluol, with an average value of $2.45 a gallon. Crude benzol, which in 1914 and previous years was used to some extent for motor fuel, contained the toluol, which is now separated out and sold at fancy prices.

More than 138,000,000 gallons of tar was obtained from coke ovens and sold for $3,568,384 in 1915.

The ammonia, of which nearly 100,000 tons was reported as sulphate and the remainder as liquor (10,626,612 gallons) and anhydrous ammonia (30,002,196 pounds), the total being equivalent to 197,128 tons of sulphate, had a value of $9,867,475. Surplus gas to the extent of 84,356,000,000 cubic feet, valued at $8,625,000, was sold or used. Of that quantity 17,196,000,000 feet was used as illuminating gas, 27,591,000,000 feet as domestic fuel, and 39,569,000,000 feet as fuel for steam raising, open-hearth furnaces, gas engines, and other industrial purposes. These by-products, which had a total value of $29,824,579, were obtained by the carbonization of 19,500,000 tons of coal, from which was also obtained 14,000,000 tons of coke, valued at $48,500,000. The total value of the coke and by-products was more than $78,300,000.

By-products obtained from coke-oven operations in 1915.

Product.	Quantity.	Value.	Average value.
Tar obtained and sold.....gallons..	138,414,601	$3,568,384	$0.026
Ammonia obtained and sold:			
Sulphate.....pounds..	199,900,487	5,648,958	.028
Liquor.....gallons..	10,626,612	1,240,473	.117
Anhydrous or free ammonia [a].....pounds..	30,002,196	2,978,044	.099
Gas produced.....M cubic feet..	213,667,614	.....	.....
Surplus gas sold or used:			
Illuminating.....do....	17,196,426	3,083,311	.179
Domestic fuel.....do....	27,590,624	3,158,129	.114
Industrial fuel.....do....	39,568,864	2,383,459	.060
Benzol products:			
Crude light oils.....gallons..	13,082,678	4,304,281	.33
Secondary light oils.....do....	182,039	28,731	.16
Benzol.....do....	2,516,483	1,428,323	.568
Toluol.....do....	623,506	1,529,803	2.45
Solvent naphtha.....do....	196,151	46,283	.24
Naphthalene.....pounds..	465,865	46,959	.10
Other products [b].....	.....	379,491	.....
		29,824,579	
Coke.....net tons..	14,072,895	48,558,325	3.45
		78,382,904	

[a] Includes liquor and sulphate sold on pound basis of NH_3.
[b] Includes breeze, retort carbon, domestic coke and coke dust, and aniline oil.

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By-products obtained in the manufacture of coke in 1913, 1914, and 1915.

Products obtained and sold.	1913		1914		1915	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Surplus gas.....M cubic feet..	64,553,941	$5,694,691	61,364,375	$6,009,583	84,355,914	$8,624,899
Tar.....gallons..	115,145,025	2,830,158	109,901,315	2,867,274	138,414,601	3,568,384
Ammonia, sulphate or reduced to equivalent in sulphate, pounds.....	173,342,349	5,324,444	170,763,906	4,696,590	199,900,487	5,648,958
Ammonia liquor.....gallons..	4,102,448	537,413	5,938,233	656,497	10,636,612	1,240,473
Anhydrous ammonia, [a] pounds	28,663,936	2,135,656	25,370,509	2,300,137	30,092,196	2,978,044
Other by-products [b].....	.....	403,579	.....	997,007	.....	7,763,821
Total value of by-products.....	.....	16,925,941	.....	17,529,088	.....	29,824,579
Coke.....net tons..	12,714,700	48,637,852	11,219,943	38,080,167	14,072,895	48,558,325
Grand total.....	.....	65,563,793	.....	55,609,255	.....	78,382,904

[a] Mainly ammoniacal liquor and sulphate sold on pound basis of NH_3. [b] Mainly benzol products.

The accompanying diagram (fig. 23) shows graphically the quantity of coal carbonized or treated in by-product ovens and the quantities of by-products obtained; also the value at the ovens of the coke and the resultant products. The by-products shown in the preceding tables in various units, as gallons and cubic feet, have been reduced to net tons for comparison. The weight of gas used, 32 pounds per 1,000 cubic feet, was calculated from an average analysis of debenzolized gas. Tar was considered to have a specific gravity of 1.14, and light oil a specific gravity of 0.88. All ammonia was reduced to tons of NH_3. Surplus gas only is shown, as no value is attached to gas consumed in the process or wasted.

Although represented by the least number of tons, ammonia was the most valuable of the by-products. Benzol products made up but a small part by weight of the total, but had a high value. The importance of the by-products, all of which are wasted in beehive ovens, is plainly shown by this diagram. The by-products represent but 13 per cent by weight of all products, but their value is 38 per cent of the total.

If to the quantity of coke and by-products shown in figure 23 are added the 2,069,000 tons of gas used in the process (or wasted) and the water in the coal (estimated at 3 per cent), approximately 587,000 tons, there remain unaccounted for, in round numbers, only 545,000 tons, or 2.8 per cent, of the 19,554,000 tons of coal charged into the ovens. There is a loss, sometimes as high as 1 per cent, in the handling of the coal from the railroad cars in which it was weighed, through crushers (when such treatment is given), in and out of storage piles, and finally into the coke ovens, which would account for a portion of this difference. These results appear therefore to be well within the probable limits of error.

The average quantities of the different by-products recovered per ton of coal are shown in the following table. For tar, gas, and ammonia the averages were calculated from the data given in preceding tables covering total coal carbonized and products obtained. A portion of the gas produced, however, was treated for recovery of benzol, and to determine the quantity of coal from which the light oils were obtained the records of the individual plants were considered and

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allowance was made for those portions of the year during which benzol equipment was in operation. In this manner it has been estimated that the benzol products reported (16,600,000 gallons) were obtained

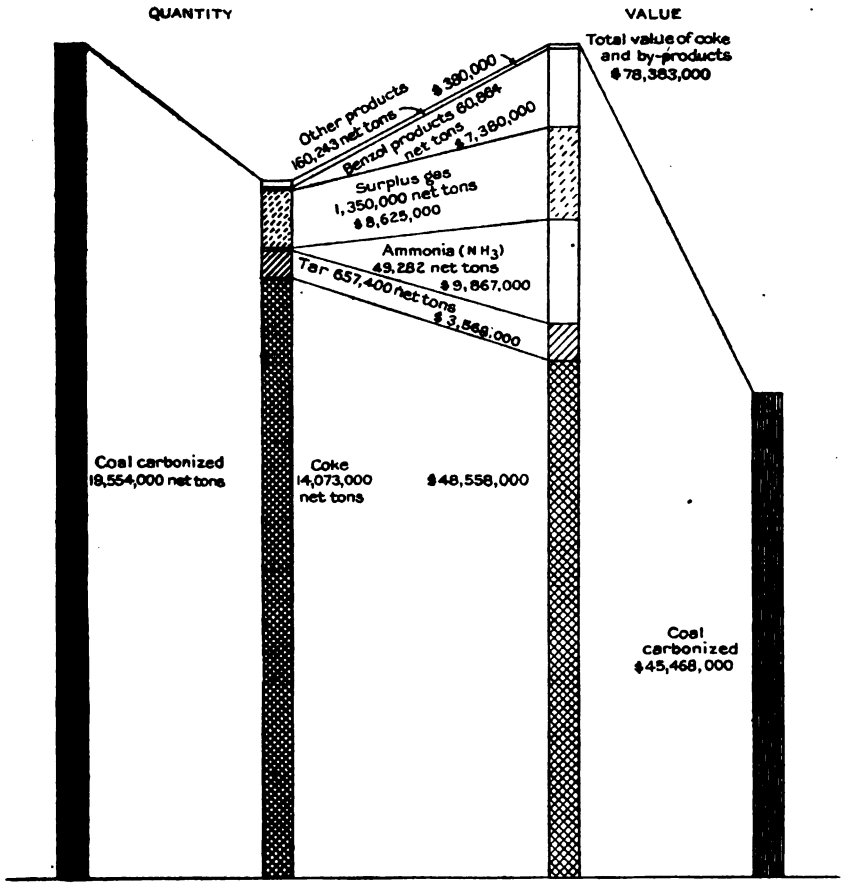
QUANTITY
VALUE
Total value of coke and by-products $78,383,000
Other products 160,243 net tons $380,000
Benzol products 60,864 net tons $7,380,000
Surplus gas 1,350,000 net tons $8,625,000
Ammonia (NH_3) 49,282 net tons $9,867,000
Tar 657,400 net tons $3,569,000
Coal carbonized 18,554,000 net tons
Coke 14,073,000 net tons
$48,558,000
Coal carbonized $45,468,000

FIGURE 23.—Diagram showing quantity and value of coal carbonized in by-product coke ovens in the United States in 1915, and quantity and value of the products obtained.

from 10,763,300 tons of coal (the total carbonized in by-product ovens in 1915 was 19,554,000 tons), and that the average yield was 1.54 gallons per net ton of coal.

Average yield of by-products per net ton of coal (2,000 pounds) from all operations in 1915.

Coke	pounds..	1,440
Tar	gallons..	7.1
Ammonium sulphate	pounds..	20.1
Light oil	gallons..	1.54
Gas:		
Total	cubic feet..	10,950
Surplus sold or used	do....	4,325
Burned in coking process	do....	6,270
Wasted	do....	355

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The yield of coke per ton of coal in different plants ranged from 1,340 to 1,550 pounds. Several operators reported the recovery of more than 10 gallons of tar (one, 13 gallons) from 2,000 pounds of coal and some showed as little as 5.5 gallons. Twelve operators reported their ammonia in the form of sulphate, and the average recovery in these operations was 20 pounds of sulphate per ton of coal. Eighteen operators reported their ammonia as pounds of NH_3, with an average of 5.34 pounds of NH_3 recovered from each 2,000 pounds of coal. The other operators reported their ammonia either all or in part as liquor. Individual operations showed average recovery ranging from 4.33 to 6 pounds of NH_3 and from 13½ to 25 pounds of ammonium sulphate per ton of coal. The widest range is found in the recovery of benzol at the different plants. Several showed less than 1 gallon (from 0.5 to 0.7 gallon); a number saved between 1 and 2 gallons; and nearly one-third recovered more than 2 gallons of light oil per 2,000 pounds of coal. Undoubtedly the newness of many of the installations and unfamiliarity with the apparatus operated to lower the recovery in certain works. Many of the producers were under contract to supply the oils as rapidly as possible, and little time could be spared for experimenting or for improving the process. In a number of places only the more valuable and easily obtainable oils were distilled, and stocks of residues have accumulated for later treatment. A part of these residues is not included in the statistics, and this, of course, lowers slightly the calculated yield. In view of what has been accomplished in the old and in some of the new works, it appears reasonable to expect that when the benzol industry is on a more normal basis the yield of light oil will be nearer 2.5 gallons per ton than the 1.5 recorded in 1915.

Many of the plants are not equipped for fractionating the oils, but ship their crude products to refineries or chemical works for further treatment, and for that reason the greater part of these products were reported and are shown here as crude and secondary oils.

DISTRIBUTION OF COKE, BY STATES.

CONSUMPTION.

In the last few years there has been more or less inquiry for statistics covering the uses as well as the markets in which coke is sold. To obtain statistics of that nature for the year 1915 a special inquiry was sent out by the Geological Survey subsequent to the regular canvass for production. The operators' replies were both complete and prompt and no difficulty was experienced in securing information, except from a few localities in West Virginia and from some of the Connellsville operators. The greater part of the so-called "merchant coke" of southwestern Pennsylvania is sold through brokers and frequently passes through several hands before reaching the consumer. For this reason the operator does not have a record of the destination of his product and not all of the brokers have records in such form as would afford data of the type sought by the Survey. To supply these deficiencies other reliable sources of information have been drawn upon, and it is believed that the statistics here presented are fairly accurate.

The coke of domestic origin consumed in the United States in 1915 was 40,341,223 net tons, of which 36,702,573 tons, or 91 per cent,

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was furnace coke; 1,664,548 tons, or 4 per cent was foundry coke; and 1,974,102 tons, or 5 per cent, was used for other purposes, mainly domestic, although some of this coke was used by railroads as locomotive fuel and a small quantity was taken by chemical works. The destination of 193,133 tons, or 0.5 per cent of the output in 1915, was not specified, but it may be considered as consumed in this country. Imports of coke in 1915 (see p. 556) amounted to 53,222 net tons (47,520 gross tons), used chiefly in the Western and Northwestern States. The total consumption of coke in the United States (exclusive of gas-house coke, which is not considered in this report) was 40,587,578 tons. Exports amounted to 884,781 tons, or 2 per cent of the total output, and 162,013 tons were on hand and had not been disposed of by the operators at the close of the year.

FURNACE COKE.

The largest use of coke is, of course, in making iron, and the leading pig iron producing States show the greatest consumption of blast-furnace fuel. Pennsylvania manufactures coke greatly in excess of furnace requirements, but the adjacent States (Ohio and New York), though producing large quantities, import coke, mainly from Pennsylvania. Illinois likewise finds it necessary to draw upon other States for its supply of furnace fuel. The production in Indiana is slightly above domestic requirements. In Alabama production and consumption of furnace coke are about equal.

These conditions are shown graphically in figure 24. New York has no coal deposits and the coal in Ohio is not used to any extent for making coke. New York and Ohio, which in the past have depended largely upon Connellsville coke from Pennsylvania, are the States therefore in which the greatest progress in the manufacture of by-product coke will be made in the future; in fact, at the close of 1915 there were 6 by-products plants with 657 ovens in course of erection in Ohio, and it is understood that others are projected. Ohio had 343 by-product ovens in operation in 1915.

Coke designated by the producers as furnace coke was reported as shipped to several States in which there are no iron or smelting furnaces. The aggregate of these shipments is, however, small and is considered to represent coke of furnace grade for consumption in the manufacturing industries.

FOUNDRY COKE.

Foundry coke, or coke for foundry purposes, was consumed in every State except Wyoming. The principal use of foundry coke is in the cupola for melting pig iron and scrap for castings, although it is used to a small extent for melting the nonferrous metals. A general idea of the extent of the iron-working industries in the different States is afforded by these statistics, as the quantity of iron melted is proportionate to the coke used. Pennsylvania and New York lead in the use of foundry coke, and Illinois, Alabama, and Michigan follow in order of rank.

It is estimated[1] that about 5 per cent of the coke received at foundries is fines screened out before the coke is put into the cupola.

[1] Dr. Richard Moldenke, in private communication.

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The ratio of coke used to iron melted varies from 5 to 10, but a general average of 7 is considered conservative. On this basis about 11,000,000 tons of iron were remelted in cupolas in 1915. Assuming the average mixture to be 65 per cent pig iron and 35 per cent scrap, more than 7,000,000 tons of pig iron, or 23 per cent of the total output, was recast.

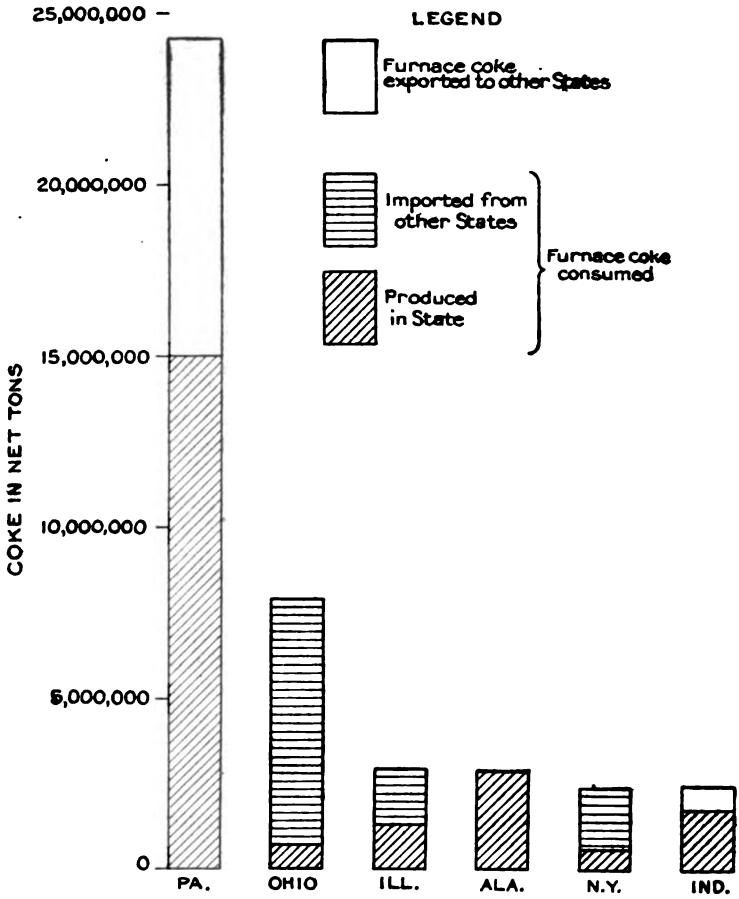

FIGURE 24.—Production and consumption of furnace coke in the six leading pig-iron producing States in 1915.

DOMESTIC COKE.

Nearly 2,000,000 tons of coke from beehive and by-product ovens were used in 1915 for heating, mainly domestic. For heating, particularly in household furnaces, it possesses many advantages and is said to be rapidly coming into favor. In a general way it has the composition and heating value of anthracite, and has the advantage of not clinkering and of igniting more easily.

The use of raw bituminous coal for heating is wasteful in that the ammonia, tar, and benzol are lost without a compensating return

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in heating value, and the increased use of coke from by-product ovens as domestic fuel is encouraging to all who desire the fullest and best use of our natural resources. Gas-house coke, which is not suitable for metallurgical uses, is largely used for heating, but its quantity is limited, and ordinarily it can not be sold as cheaply as coke made in large quantities at by-product plants.

TABLES.

Coke consumed in the United States in 1915, exclusive of imports, in net tons.

State.	Furnace.	Foundry.	Other kinds, as domestic, etc.	State.	Furnace.	Foundry.	Other kinds, as domestic, etc.
Alabama	2,870,378	110,901	.....	Montana	210,448	448	.....
Arizona	274,965	30	.....	Nebraska [b]	.....	1,710	.....
Arkansas	.....	88	.....	New England States	397	79,209	489,000
California	14,679	27,569	.....	New Jersey	79,527	64,365	.....
Colorado	550,004	21,266	.....	New Mexico	6,754	328	.....
Delaware	335	6,941	.....	New York	2,442,423	203,197	131,662
Florida	.....	1,007	.....	North Carolina and South Carolina	1,452	2,906	.....
Georgia	3,729	17,599	.....	Ohio	7,886,415	156,475	17,081
Idaho	106	44	.....	Oklahoma	.....	275	.....
Illinois	2,933,457	151,572	172,098	Pennsylvania	15,036,595	308,941	364,009
Indiana	1,781,278	18,265	146,851	Tennessee	222,202	39,546	.....
Iowa	.....	12,516	.....	Texas	42,886	16,798	.....
Kansas	4,456	18,164	5,000	Utah and Oregon	183,002	3,002	.....
Kentucky	120,300	15,076	5,245	Virginia	384,436	41,392	.....
Louisiana	.....	31,237	.....	Washington	49,411	8,124	21,185
Maryland [a]	336,127	8,773	.....	West Virginia	294,926	24,339	41
Michigan	549,888	103,266	303,052	Wisconsin	293,540	76,365	298,878
Minnesota	128,197	18,117	.....		36,702,573	1,664,548	1,974,102
Mississippi and Nevada	230	2,741	.....				
Missouri	.....	71,956	20,000				

[a] Includes District of Columbia. [b] Includes North Dakota and South Dakota.

The following tables present statistics showing, in so far as the figures can be disclosed, the source of the coke of different kinds consumed in each State:

Coke consumed in individual States in 1915, in net tons.

Alabama.

State.	Furnace.	Foundry.	Other kinds, domestic, etc.
Alabama	2,869,268	108,003	.....
Georgia and Tennessee	.....	2,696	.....
Virginia and West Virginia	1,110	202	.....
	2,870,378	110,901	.....

Arizona.

Colorado and New Mexico	274,965	.....	.....
Pennsylvania	.....	30	.....
	274,965	30	.....

Arkansas.

Alabama	.....	58	.....
Virginia and West Virginia	.....	30	.....
	.....	88	.....

California.

State	Furnace.	Foundry.	Other kinds, domestic, etc.
Alabama	.....	1,896	.....
Colorado and New Mexico	5,191	18,062	.....
Utah and Washington	9,488	.....	.....
Georgia and Tennessee	.....	4,438	.....
Pennsylvania and Wisconsin	.....	3,134	.....
Virginia and West Virginia	.....	539	.....
	14,679	27,569	.....

Colorado.

Alabama, Tennessee, and Wisconsin	.....	1,770	.....
Colorado	544,700	17,675	.....
Illinois, New Mexico, Virginia, and West Virginia	5,304	1,821	.....
	550,004	21,266	.....

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Coke consumed in individual States in 1915, in net tons—Continued.

Delaware.

State.	Furnace.	Foundry.	Other kinds, domestic, etc.
Pennsylvania	335	5,305	.....
Virginia and West Virginia	.....	1,636	.....
	335	6,941	.....

Florida.

Alabama	.....	507	.....
Virginia and West Virginia	.....	500	.....
	.....	1,007	.....

Georgia.

Alabama	.....	10,975	.....
Georgia and Tennessee	3,180	3,175	.....
Virginia and West Virginia	549	3,449	.....
	3,729	17,599	.....

Idaho.

Utah and Wisconsin	106	44	.....
	106	44	.....

Illinois.

Alabama and Kentucky	189,443	11,724	.....
Illinois	1,214,149	115,044	171,698
Indiana and Wisconsin	904,002	9,962	.....
Pennsylvania	181,284	5,093	.....
Virginia and West Virginia	444,609	9,749	400
	2,933,487	151,572	172,098

Indiana.

Illinois and Michigan	.....	8,247	.....
Indiana	1,544,854	.....	146,811
Kentucky, Ohio, and Tennessee	.....	1,180	40
Pennsylvania	236,424	4,084	.....
Virginia and West Virginia	.....	4,754	.....
	1,781,278	18,265	146,851

Iowa.

Illinois and Wisconsin	.....	11,948	.....
Virginia and West Virginia	.....	568	.....
	.....	12,516	.....

Kansas.

State.	Furnace.	Foundry.	Other kinds, domestic, etc.
Pennsylvania, Tennessee, Virginia, and West Virginia	.....	1,052	.....
Illinois and Wisconsin	.....	3,166	.....
Missouri and New Mexico	4,456	13,946	5,000
	4,456	18,164	5,000

Kentucky.

Alabama and Tennessee	.....	521	.....
Kentucky	118,227	12,875	5,245
Virginia and West Virginia	2,073	1,680	.....
	120,300	15,076	5,245

Louisiana.

Alabama, Virginia, and West Virginia	.....	31,237	.....
	.....	31,237	.....

Maryland. [a]

Maryland	313,283	.....	.....
Pennsylvania	12,643	4,053	.....
Virginia and West Virginia	10,201	4,720	.....
	336,127	8,773	.....

Michigan.

Michigan, Tennessee, and Wisconsin	263,402	84,600	303,052
Pennsylvania	286,288	16,216	.....
Virginia and West Virginia	198	2,450	.....
	549,888	103,266	303,052

Minnesota.

Minnesota and Wisconsin	127,847	9,570	.....
Illinois and Pennsylvania	350	6,297	.....
Virginia and West Virginia	.....	2,250	.....
	128,197	18,117	.....

Missouri.

Alabama, Kentucky, Missouri, and Tennessee	.....	54,500	20,000
Illinois and Wisconsin	.....	4,678	.....
Pennsylvania	.....	12,335	.....
Virginia and West Virginia	.....	443	.....
	.....	71,956	20,000

[a] Includes District of Columbia.

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Coke consumed in individual States in 1915, in net tons—Continued.

Montana.

State.	Furnace.	Foundry.	Other kinds, domestic, etc.
Colorado and Utah	210,448	.....	.....
Illinois and Wisconsin	.....	448	.....
	210,448	448	.....

Nebraska.[a]

Illinois, Pennsylvania, and Wisconsin	.....	1,710	.....
	.....	1,710	.....

New England.

Massachusetts and New York	.....	17,384	489,000
Pennsylvania	397	59,590	.....
Virginia and West Virginia	.....	2,235	.....
	397	79,209	489,000

New Jersey.

Pennsylvania	43,190	44,912	.....
Virginia and West Virginia	36,337	19,453	.....
	79,527	64,365	.....

New Mexico.

Colorado and New Mexico	6,754	328	.....
	6,754	328	.....

New York.

New York and Michigan	547,117	21,796	111,662
Pennsylvania	1,822,594	93,034	20,000
Virginia and West Virginia	72,712	88,367	.....
	2,442,423	203,197	131,662

North Carolina and South Carolina.

Virginia and West Virginia	1,452	2,906	.....
	1,452	2,906	.....

Ohio.

Kentucky	149,920	17,900	10,000
Michigan and Tennessee	.....	2,766	.....
Ohio	677,859	.....	6,629
Pennsylvania	6,727,224	120,089	.....
Virginia and West Virginia	331,412	15,720	452
	7,886,415	156,475	17,081

[a] Includes North Dakota and South Dakota.

Oklahoma.

State.	Furnace.	Foundry.	Other kinds, domestic, etc.
Kentucky, Virginia, West Virginia, and Wisconsin	.....	275	.....
	.....	275	.....

Oregon.

Alabama, Virginia, Washington, and West Virginia	546	737	.....
	546	737	.....

Pennsylvania.

New Jersey, Virginia, and West Virginia	288,985	10,964	255,976
Pennsylvania	14,747,610	297,977	108,033
	15,036,595	308,941	364,009

Tennessee.

Alabama, Georgia, and Kentucky	.....	15,965	.....
Tennessee	208,550	22,897	.....
Virginia and West Virginia	13,652	684	.....
	222,202	39,546	.....

Texas.

Alabama	.....	14,774	.....
Colorado and New Mexico	42,886	.....	.....
Virginia, West Virginia, and Wisconsin	.....	2,024	.....
	42,886	16,798	.....

Utah.

Colorado, Illinois, Tennessee, and Utah	182,456	2,265	.....
	182,456	2,265	.....

Virginia.

Pennsylvania	.....	583	.....
Virginia and West Virginia	384,436	40,809	.....
	384,436	41,392	.....

Washington.

Alabama, Pennsylvania, and Wisconsin	.....	623	.....
Washington	49,411	7,501	21,185
	49,411	8,124	21,185

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Coke consumed in individual States in 1915, in net tons—Continued.

West Virginia.				Wisconsin.			
State.	Furnace.	Foundry.	Other kinds, domestic, etc.	State.	Furnace.	Foundry.	Other kinds, domestic, etc.
Pennsylvania	164,926	739	41	Illinois	79,343	3,310	.....
Virginia and West Virginia	129,998	23,600	.....	Indiana and Wisconsin	213,141	72,483	298,878
				Pennsylvania, Virginia, and West Virginia	1,056	622	.....
	294,926	24,339	41		293,540	76,365	298,878

SHIPMENTS AND EXPORTS.

The following tables show the quantity of coke of various kinds produced and the quantity exported from each State in 1915. As stated on page 557, the figures for exports of coke compiled from the reports of the operators do not fully agree with the official figures obtained by the Bureau of Foreign and Domestic Commerce, but the difference, in view of the methods of compilation, is not great. The distribution for consumption of the coke from producing States is also given where such data are permitted by the producers to be disclosed.

Coke produced in 1915, in net tons.

State.	Shipments.			Exports.	Unspecified.	In (+) or out (−) of stock piles.	Total production.
	Furnace.	Foundry.	Other kinds, domestic, etc.				
Alabama	2,869,268	172,991	.....	1,020	.....	+ 28,532	3,071,811
Colorado	625,012	37,088	.....	8,212	.....	+ 626	670,938
Georgia	.....	20,039	.....	.....	.....	.....	20,039
Illinois	1,293,492	133,892	171,698	.....	.....	+ 87,916	1,686,998
Indiana	2,448,929	.....	146,811	.....	172,359	.....	2,768,099
Kentucky	457,590	53,262	15,245	.....	.....	.....	526,097
Maryland	313,283	.....	.....	.....	.....	.....	313,283
Massachusetts	.....	15,000	489,000	.....	.....	+ 438	504,438
Minnesota	127,847	.....	.....	.....	.....	.....	127,847
New Mexico	282,053	154	.....	109,302	965	− 3,063	389,411
New York	547,117	23,814	111,662	.....	.....	+ 1,868	684,461
Ohio	677,859	.....	6,669	.....	.....	+ 130	684,658
Pennsylvania	24,224,323	667,797	128,074	618,120	.....	− 15,452	25,622,862
Tennessee	211,780	45,208	.....	.....	.....	+ 35	256,973
Virginia, West Virginia	1,704,252	242,268	852	59,736	19,809	− 5,664	2,021,253
Michigan, Missouri, New Jersey, Utah, Washington, Wisconsin	919,818	253,035	904,091	88,391	.....	+ 66,647	2,231,982
	36,702,573	1,664,548	1,974,102	884,781	193,133	+162,013	41,581,150

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Coke produced in individual States in 1915, in net tons.

Alabama.

Destination.	Furnace.	Foundry.	Other kinds, domestic, etc.	Export.
Alabama	2,869,268	106,003	0	.....
California	0	1,396	0	.....
Florida	0	507	0	.....
Louisiana	0	30,583	0	.....
Georgia and Mississippi	0	13,716	0	.....
Tennessee, Kentucky, and Illinois	0	1,584	0	.....
Missouri and Arkansas	0	1,884	0	.....
Colorado, Oregon, and Washington	0	544	0	.....
Texas	0	14,774	0	.....
	2,869,268	172,991	0	1,020

Colorado.

Arizona, California, New Mexico, and Texas	57,503	18,360	0	.....
Colorado	544,700	17,675	0	.....
Montana and Utah	22,809	1,053	0	.....
	625,012	37,088	0	8,212

Illinois.

Colorado and Utah	0	150	0	.....
Montana and Nebraska	0	269	0	.....
Minnesota and Wisconsin	79,343	9,085	0	.....
Iowa, Kansas, and Missouri	0	3,614	0	.....
Illinois	1,214,149	120,774	171,698	.....
Indiana	0			.....
	1,293,492	133,892	171,698	.....

Indiana.

Illinois and Wisconsin	904,075	0	146,811	.....
Indiana	1,544,854			.....
	2,448,929	0	146,811	.....

Kentucky.

Illinois, Indiana, and Ohio	339,363	30,398	10,000	.....
Kentucky and Tennessee	118,227	14,565	5,245	.....
Missouri and Oklahoma	0	8,299	0	.....
	457,590	53,262	15,245	.....

New Mexico.

Destination.	Furnace.	Foundry.	Other kinds, domestic, etc.	Export.
New Mexico and Texas	40,250	30	0	.....
Arizona and California	232,043	0	0	.....
Colorado and Kansas	9,760	124	0	.....
	282,053	154	0	109,302

New York.

New England and New York	547,117	23,814	111,662	.....
	547,117	23,814	111,662	.....

Pennsylvania.

Arizona, California Kansas, Nebraska, and Washington	0	3,265	0	.....
Illinois	181,284	5,093	0	.....
Indiana	236,424	4,084	0	.....
Massachusetts	12,643	4,053	0	.....
Michigan	286,288	16,216	0	.....
Missouri	0	12,335	0	.....
New England	397	59,590	0	.....
New Jersey	43,190	44,912	0	.....
New Mexico	0	93,034	0	.....
New York	1,822,594	0	20,000	.....
Ohio	6,727,224	120,089	0	.....
Pennsylvania	14,747,610	297,977	108,033	.....
Virginia and West Virginia	164,928	1,322	41	.....
Delaware, Minnesota, and Wisconsin	1,741	5,827	0	.....
	24,224,323	667,797	128,074	618,120

Tennessee.

Alabama, Georgia, and Kentucky	3,180	2,158	0	.....
California and Utah	0	2,494	0	.....
Colorado, Kansas, and Missouri	0	16,018	0	.....
Indiana, Michigan, and Ohio	0	1,641	0	.....
Tennessee	208,550	22,897	0	.....
	211,730	45,208	0	.....

Utah and Washington.

California	9,488	0	0	.....
Idaho, Montana, and Nevada	187,975	0	0	.....
Oregon	232,413	8,088	0	.....
Utah			0	.....
Washington			21,185	.....
	429,876	8,088	21,185	45,405

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Coke produced in individual States in 1915, in net tons—Continued.

Virginia and West Virginia.

Destination.	Furnace.	Foundry.	Other kinds, domestic, etc.	Export.
Alabama, Florida, and Kentucky	3,183	2,382	0	.....
California	0	539	0	.....
Delaware	0	1,636	0	.....
Georgia	549	3,449	0	.....
Illinois	444,609	9,749	400	.....
Indiana	0	4,754	0	.....
Iowa	0	568	0	.....
Minnesota and Wisconsin	0	2,872	0	.....
Colorado, Kansas, and Oregon	0	1,857	0	.....
Maryland	10,201	4,720	0	.....
Michigan	198	2,450	0	.....
Arkansas, Louisiana, and Texas	0	1,991	0	.....

Virginia and West Virginia—Continued.

Destination.	Furnace.	Foundry.	Other kinds, domestic, etc.	Export.
Missouri and Oklahoma	0	563	0	.....
New England	0	2,235	0	.....
New Jersey	26,337	19,453	0	.....
New York	72,712	88,367	0	.....
North Carolina and South Carolina	1,452	2,906	0	.....
Ohio	331,412	15,720	452	.....
Pennsylvania	275,513	10,964	0	.....
Tennessee	13,552	664	0	.....
Virginia	334,436	40,809	0	.....
West Virginia	129,998	23,600	0	.....
	1,704,252	242,268	852	59,736

IMPORTS AND EXPORTS.[1]

IMPORTS OF COKE.

The imports of coke in 1915 were 53,222 net tons, a decrease of more than 80,000 tons, compared with 1914. The greater part of the foreign coke imported in 1915 came from British Columbia and was used by copper and lead smelters in the Northwest.

Coke imported and entered for consumption in the United States, 1908–1915.

Year.	Quantity. (net tons).	Value.	Year.	Quantity. (net tons).	Value.
1908	147,427	$606,294	1912	123,614	$488,398
1909	191,253	736,120	1913	101,212	435,157
1910	172,716	625,130	1914	133,226	551,104
1911	77,923	254,455	1915	53,222	222,382

Coke imported into the United States in 1915, by customs districts.

District.	Quantity (net tons).	Value.	District.	Quantity (net tons).	Value.
Hawaii	170	$796	Michigan	941	$3,107
San Francisco	15,849	53,389	Montana and Idaho	27,815	125,219
Washington	1,033	5,502		53,222	222,382
Buffalo	7,414	34,279			

[1] In the reports of the Bureau of Foreign and Domestic Commerce, Department of Commerce, from which these figures are obtained, the quantities are expressed in gross tons of 2,240 pounds. These have been reduced to net (short) tons in order to make them conform to the standard unit of measurement of this report.

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IMPORTS OF COAL-TAR PRODUCTS.

The imports of coal-tar products for the last seven years are given in the following table. The value of the imports of these materials shows a large decrease, from $9,646,000 in 1914 to $5,015,000 in 1915. In addition to the products listed in this table, anthracene and anthracene oil (duty free), valued at $11,509, were imported in 1915, as against imports of the same products valued at $64,829 in 1914.

Coal-tar products imported into the United States, 1909–1915.

Year.	Salicylic acid.		Alizarin and colors or dyes, natural and artificial.		Aniline salts.		Coal-tar colors or dyes, not specially provided for.	
	Value.	Duty.	Value.	Duty.	Value.	Duty.	Value.	Duty.
1909	.....	.....	$1,191,874	Free.	$553,503	Free.	$6,431,767	$1,929,530
1910	.....	.....	430,393	Free.	501,369	Free.	5,867,331	1,760,098
1911	$3,480	$915	996,794	Free.	410,193	Free.	6,444,595	1,933,379
1912	9,543	2,469	1,514,344	Free.	354,226	Free.	7,204,453	2,161,336
1913	2,969	613	1,493,840	Free.	323,420	[a]$4,034	7,253,788	2,176,136
1914	9,245	1,051	1,216,907	Free.	180,905	18,091	6,868,818	2,060,629
1915	18,373	1,357	854,818	Free.	64,806	6,481	3,352,222	1,005,658

Year.	Coal tar, all preparations, not colors or dyes.		Coal-tar products, not medicinal, not dyes, known as benzol, toluol, etc.		Total.	
	Value.	Duty.	Value.	Duty.	Value.	Duty.
1909	$693,608	$138,768	$960,724	Free.	$9,831,476	$2,068,298
1910	594,252	118,849	962,232	Free.	8,355,577	1,878,947
1911	659,407	131,881	1,128,409	Free.	9,642,878	2,066,175
1912	659,305	131,861	998,767	Free.	10,740,638	2,295,666
1913	702,721	131,268	1,186,090	[b]$11,678	10,962,828	2,323,729
1914	556,614	80,179	813,710	52,964	9,646,199	2,212,914
1915	197,845	29,606	526,641	20,401	5,014,705	1,063,503

[a] Dutiable on and after Oct. 4, 1913.
[b] All products in this class became dutiable on Oct. 4, 1913, except naphthalene, phenol, and cresol.

EXPORTS OF COKE.

Exports of coke in 1915 were 895,509 net tons, a large increase over 1914, but a less quantity than was exported in 1913 or in any other year since 1908. The largest user of United States coke is eastern Canada, to which more than 650,000 tons were shipped in 1915. The coke exported to Chile, Peru, and Mexico was principally for copper smelting. South American countries took a total of 48,216 tons and European ports received 28,737 tons of the coke made in the United States in 1915.

The statistics of exports are presented in the following tables. It will be noted that the total of the exports, according to the Bureau of Foreign and Domestic Commerce, does not agree with that shown by the reports from operators in the table on page 554. The difference may be ascribed to two factors—some gas-house coke may have been exported and it is quite probable that the declared weight was only approximate.

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Coke exported from the United States, 1909–1915.

Year.	Quantity (net tons).	Value.	Year.	Quantity (net tons).	Value.
1909	1,002,916	$3,262,673	1913	987,395	$3,209,980
1910	984,618	3,053,293	1914	663,585	2,235,686
1911	1,023,727	3,215,990	1915	895,509	3,092,498
1912	912,376	3,002,742			

Coke exported from the United States in 1915, by customs districts.

District.	Quantity (net tons).	Value.	District.	Quantity (net tons).	Value.
Arizona	38,409	$111,907	Philadelphia	16,612	$64,168
Buffalo	469,187	1,466,872	Porto Rico	2	45
Dakota	6,022	19,333	Rochester	5,219	18,867
Duluth-Superior	1,211	3,182	Sabine, Tex.	6	52
Eagle Pass	452	3,232	St. Lawrence	20,370	93,575
El Paso	101,963	366,063	San Francisco	176	2,914
Laredo	2,137	7,813	Southern California	1	19
Maryland	39,526	137,596	Vermont	1,047	3,368
Michigan	89,986	323,857	Virginia	36,851	144,033
Montana and Idaho	1	11	Washington	50,677	243,014
New Orleans	196	740			
New York	8,073	55,535		895,509	3,092,498
Ohio	7,335	21,902			

Coke exported from the United States in 1915, by countries.

Country.	Quantity (net tons).	Value.	Country.	Quantity (net tons).	Value.
Argentina	3,911	$15,713	Guatemala	66	$264
Australia	13	94	Haiti	2	17
Bolivia	9	50	Honduras	24	111
Brazil	544	2,479	Italy	23,092	99,172
British Honduras	16	53	Japan	13	74
Canada	651,139	2,198,727	Mexico	151,661	521,880
Chile	30,548	108,186	Nicaragua	6	21
Colombia	109	748	Norway	2,522	17,800
Costa Rica	85	803	Panama	263	2,020
Cuba	12,578	51,107	Peru	12,092	44,570
Danish West Indies	1	10	Salvador	103	1,020
Dutch East Indies	130	580	Santo Domingo	22	200
Dutch West Indies	16	111	Spain	92	326
Ecuador	28	227	Trinidad and Tobago	15	100
England	728	4,057	Uruguay	649	2,757
France	454	3,040	Venezuela	63	481
French Oceania	2,630	8,218			
French West Indies	38	254		895,509	3,092,498
Greece	1,849	7,228			

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41, 643	(*h*)	108, 774	(*h*)	564, 191	21, 795, 855	1901
23, 296	(*h*)	146, 099	(*h*)	598, 869	25, 401, 730	1902
11, 050	(*h*)	143, 913	(*h*)	932, 428	25, 274, 281	1903
58, 259	(*h*)	109, 284	(*h*)	1, 451, 172	23, 661, 106	1904
39, 638	(*h*)	277, 130	(*h*)	1, 660, 857	32, 231, 129	1905
17, 747	(*h*)	293, 994	(*h*)	2, 085, 617	36, 401, 217	1906
55, 125	(*h*)	270, 634	0	2, 528, 739	40, 779, 564	1907
74, 565	(*h*)	159, 578	0	2, 245, 321	26, 033, 518	1908
73, 967	(*h*)	222, 711	0	2, 509, 306	39, 315, 065	1909
01, 646	652, 459	282, 315	0	2, 169, 772	41, 708, 810	1910
31, 927	686, 172	311, 382	0	3, 023, 607	35, 551, 489	1911
13, 906	794, 618	388, 669	0	2, 530, 018	43, 983, 599	1912
57, 945	758, 486	351, 846	0	2, 601, 121	46, 299, 530	1913
52, 572	457, 370	521, 638	0	2, 389, 565	34, 555, 914	1914
39, 411	684, 461	684, 658	0	2, 095, 430	41, 581, 150	1915
32, 669	.....	5, 723, 404	.....	.....	722, 733, 061	

ıa. *f* Included with Illino ss than three producers.

on of C. E. Lesher, geologist.

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PETROLEUM.

By JOHN D. NORTHROP.

INTRODUCTION.

Of the many industries dependent for their existence on mineral substances, it is doubtful if any other one has attracted in recent years the degree of popular interest that is manifest in the petroleum industry. The wide distribution of petroleum, both geographically and geologically, the unique methods employed in obtaining and transporting it, the endless variety of useful products derived from it, and the fortunes made and lost in its quest are topics in which popular interest is ever increasing. Of the various elements into which this interest may be resolved, the principal one is that involving the products of petroleum, whose diversity and utility have given them important places in every industry and in every household. The marvelous development of the automobile industry in the last decade, particularly since the advent of low-priced cars, has resulted in a demand for gasoline and lubricating oils that has taxed the industry to its utmost and has at the same time created an interest and concern in that industry which is as vital as it is country wide.

With the increased realization of the magnitude of the petroleum industry and of its importance as a contributor to the necessities and pleasures of everyday life there have come both a more general recognition of the fact that the petroleum resources of the United States are not inexhaustible and a growing demand for a strict accounting of the annual drafts made on the diminishing stores of this valuable mineral.

This demand which, until recent years, has emanated chiefly from sources within the industry itself was recognized by the United States Geological Survey at the time of its organization as the expression of a vital economic need, and since 1882 such annual accounting has been made. The present chapter, which is the thirty-fourth in this series of statistical records, presents a review of the yield of crude petroleum and of development in the oil fields of the United States in 1915 and includes brief notes on the trend of developments in foreign oil fields so far as conditions can be ascertained.

General conditions.—As a result of the overload put on the transporting and refining branches of the petroleum industry by the excessive output of crude oil in 1914, the year 1915 may be characterized as a period of readjustment in which activity in production was purposely retarded. The Cushing pool, in eastern Oklahoma, which had completely dominated the industry since June, 1914, attained its maximum production, estimated at 300,000 barrels a day, in April, 1915, and entered a stage of rather abrupt decline, which, with the passing of millions of barrels of storage oil in that area into the control

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of a few strong companies, resulted in an increased demand for oil produced in other parts of the country. This demand was accompanied by advancing prices, which served to restore the confidence of oil producers, and before the close of the year activity in drilling had attained normal proportions in practically all the proved fields, and a notable wildcat campaign had been started in the Mid-Continent and Gulf coast regions.

Of equal importance with the withdrawal of the stocks of oil at Cushing from the open market in effecting the rapid rise of oil prices after the slump in Cushing production had set in was the increased demand for oil arising from a number of new refineries that had been installed during the period of overproduction and low prices.

Thus the petroleum industry has completed another stage in its life history, passing in the remarkably short period of two years from an era of high prices and threatened shortage of crude material through a period of overproduction and low prices and emerging, greatly enlarged as to refining capacity, to face once more a threatened shortage of crude supply. By this method of growth, in ever-expanding circles, the petroleum industry has attained its present magnitude. That the petroleum resources of this country have thus far been equal to the increasing demands placed on them by this growth is a matter of record, but that they can continue indefinitely so to respond is a belief wholly at variance with natural laws and one not shared by thoughtful oil operators. The relatively slow decline of oil prices in the face of overproduction and the rapid rise to normal and more than normal prices following a period of excessive production give ample evidence of the concern felt by the large refiner for his future supply of crude material. Additional evidence that far-sighted men within the industry itself already feel that the crest in production is close at hand is afforded by the promptness with which the field storage at Cushing was purchased when the daily output of the pool began to record a steady decline and by the phenomenal wave of wildcat activity that swept over the Mid-Continent, Gulf Coast, and Rocky Mountain States with the passing of Cushing.

Prices.—The low scale of prices for crude petroleum inherited from 1914 remained in effect without permanent advance at any point from January to August, when, led by "Oklahoma and Kansas grade," prices for all refinable crudes began an upward movement that was still underway at the close of 1915 and that did not result in a stable, high-level market until March, 1916. Such market changes as took place between January and August were retrogressive except for a slight stiffening of prices for certain grades of Appalachian oil, effective January 4, which, in spite of the rising tide of Oklahoma production, remained in force until March 15.

A striking feature of the market advances during the last third of the year was the rapidity with which they succeeded one another—a circumstance that, in the light of subsequent events, was no less notable than the high levels reached before stability was attained.

The upward turn in the market for Appalachian grades during the first week of January occasioned no little surprise to close observers of conditions throughout the country, who failed to detect any sound economic basis for the advance other than the decline in output of these high-grade crudes, which had unquestionably been accelerated by the downward course of prices since April, 1914, and the urgent

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need of some incentive to revive activity on the part of the indifferent producer and wildcatter in the eastern districts. In the face, however, of a steady increase in the output of competing crude in Oklahoma, the influence of this advance was negligible. From the low level of $1.35 a barrel, reached April 3, after nearly 12 months of retrogression, and maintained to August 14, 1915, "Pennsylvania grade," the market standard, advanced steadily during the closing months of the year, reaching $2 a barrel on November 18 and $2.25 a barrel on December 30, and disclosed a strength which indicated a rapid return to the $2.50 level attained before the advent of Cushing. This objective was reached on March 6, 1916, less than seven months from the time of the initial upward turn, a period less by five months than that during which the market for the same grade of oil was declining.

"Oklahoma and Kansas grade," whose course is typical of Mid-Continent movements, recorded an even more rapid recovery. From its low level of 40 cents a barrel maintained from February 15 to August 2, 1915, after a period of decline from $1.05 a barrel commencing April 8, 1914, this grade advanced to $1.20 a barrel in a little more than four months, passing its former high level on December 13 and attaining the price quoted on the following day.

Market quotations for petroluem produced in the coastal pools of Texas and Louisiana reflect largely the state of balance between supply and demand with respect to fuel oils and bear little relation to the conditions affecting prices of high-grade crudes produced in the Mid-Continent and the eastern fields. Credit balance quotations on Gulf-coast crudes ruled unusually low throughout 1915 as a consequence of an enormously increased yield of oil from the Humble pool in the Texas division, of active competition in the fuel market with Mexican crude, and of similar competition with refinery residuals from Mid-Continent sources, the last-named factor being the least important.

Significant developments.—The year 1915 was one of notable progress in practically every branch of the petroleum industry. This is particularly true with regard to refining. In this branch efforts to develop on a commercial scale an increasing number of new processes devised to increase the recovery of gasoline from all types of crude petroleum were particularly active. In this line of endeavor there were many contenders, but as far as actual results are concerned the Rittman process, conceived by a research chemist in the employ of the Bureau of Mines, appeared to offer the greatest promise of ultimate development on a scale applicable to large scale operations.

This process, which has been fully described elsewhere,[1] differs from the successful Burton process for the manufacture of motor spirits, owned by the Standard Oil Co. of Indiana, in that cracking is effected on the vapor of the oil in specially devised metal tubes instead of on the oil itself in stills or tanks. It is, moreover, adaptable to the recovery not only of gasoline but of aromatic hydrocarbons, such as benzene, toluene, xylene, anthracine, and naphthalene as well, and can be modified at will to recover these products from crude petroleum or petroleum distillates, irrespective of their base, whether

[1] Rittman, W. F., and others, Manufacture of gasoline and benzene-toluene from petroleum and other hydrocarbons: Bur. of Mines Bull. 114, 1916.

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paraffin, asphalt, or mixed. As constituting the first successful process for the recovery of appreciable quantities of aromatic hydrocarbons from petroleum the Rittman process is epoch-making.

The success of the process attained in the experimental plant placed at the disposal of the Department of the Interior by the Aetna Explosives Co. (Inc.) is such as to convince those best informed in the matter that its future perfection is a matter for the mechanical rather than the chemical engineer.

In marine circles the year 1915 recorded the advent of an unprecedented boom in construction of tank ships, which is highly gratifying to those who hope to see the greatest petroleum-producing country in the world take its rightful place in the transportation of raw material and refined products to customers in other lands less favored with natural resources of this character.

A significant trend apparent in the domestic industry in 1915, particularly in the newer fields, was the definite movement toward the consolidation of producing and refining interests and their joint expansion under centralized control. Thoughtful observers of the struggle for existence between small operators and small refiners on the one hand and their more powerful competitors on the other have long been convinced that competition in the petroleum industry could not long exist if the small refiner did not secure an independent source of petroleum supply and the small producer either an assured market or a choice of markets. Thus the movement toward centralization of control of the petroleum industry in a relatively few powerful units in position to compete with one another on practically even terms may be considered as a forward step toward a much-needed condition of stability.

With regard to the litigation between the Federal Government and petroleum operators on lands withdrawn by Executive orders of President Taft prior to the passage by Congress of the withdrawal act of June 25, 1910, notable progress was made in 1915. This was recorded in a decision [1] of the Supreme Court, handed down February 23, that removed all doubt as to the validity of the presidential withdrawals and opened the way for litigation affecting the title to practically every oil claim in the Salt Creek field in Wyoming and to 25 per cent or more of the productive oil territory on the west side of the San Joaquin Valley in California.

ACKNOWLEDGMENTS.

In presenting this report the author gratefully acknowledges his indebtedness to the 16,000 producers, transporters, and refiners of crude petroleum in the United States, for their cordial cooperation and assistance which have made possible the compilation of the statistical data here given.

For much of the general information included in the text of this report acknowledgment is tendered to the contemporary historians represented by the petroleum press. Acknowledgment in this respect is particularly due to the Oil City Derrick, the Petroleum Gazette, the National Petroleum News, the Oil and Gas Journal, the Fuel Oil Journal, the California Oil World, the California Derrick, and the Oil

[1] United States v. Midwest Oil Co., 236 U. S., 459.

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Age. Service has also been rendered by the Petroleum Age, Oil and Gas, Oildom, the Standard Oil Bulletin, and the Oil, Paint, and Drug Reporter.

For data and statistics relating to foreign petroleum production acknowledgment is made to the statistical bureaus of a number of foreign Governments, to the officials of many foreign oil companies, to the Pan American Union, and to the Bureau of Foreign and Domestic Commerce, as well as to the following foreign publications relating to the petroleum industry: The Petroleum Review, the Petroleum World, Le Moniteur du pétrole roumain, and Petroleum Zeitschrift.

By no means the least of the writer's acknowledgments are due to Miss Anne B. Coons, of the United States Geological Survey, for preparing the statistical compilations presented in this chapter.

PRODUCTION.

The quantity of petroleum actually brought aboveground in the various oil fields of the United States in 1915 is not susceptible of accurate determination by the system of voluntary reports from oil producers, on which the United States Geological Survey must depend. The incomplete data at hand permit only an estimate of the quantity of oil actually produced in excess of that marketed during the year. According to the best information available, this quantity amounted to not less than 24,800,000 barrels in 1915. Addition of these figures to those of petroleum marketed gives a total of 305,900,000 barrels as the approximate output of the oil wells of this country in 1915.

MARKETED PRODUCTION.

GENERAL STATEMENT.

Measured by marketed production, the year 1915 was the greatest in the history of the crude-petroleum industry in this country, the quantity involved being 281,104,104 barrels, as compared with the previously established record of 265,762,535 barrels attained in 1914.

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Petroleum marketed in the United States,

Year.	Pennsylvania and New York.	Ohio.	West Virginia.	California.	Kentucky and Tennessee.	Colorado.	Indiana.	Illinois.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
1859	2,000	.....	.....	.....	.....	.....	.....	.....
1860	500,000	.....	.....	.....	.....	.....	.....	.....
1861	2,113,609	.....	.....	.....	.....	.....	.....	.....
1862	3,056,690	.....	.....	.....	.....	.....	.....	.....
1863	2,611,309	.....	.....	.....	.....	.....	.....	.....
1864	2,116,109	.....	.....	.....	.....	.....	.....	.....
1865	2,497,700	.....	.....	.....	.....	.....	.....	.....
1866	3,597,700	.....	.....	.....	.....	.....	.....	.....
1867	3,347,300	.....	.....	.....	.....	.....	.....	.....
1868	3,646,117	.....	.....	.....	.....	.....	.....	.....
1869	4,215,000	.....	.....	.....	.....	.....	.....	.....
1870	5,260,745	.....	.....	.....	.....	.....	.....	.....
1871	5,205,234	.....	.....	.....	.....	.....	.....	.....
1872	6,293,194	.....	.....	.....	.....	.....	.....	.....
1873	9,893,786	.....	.....	.....	.....	.....	.....	.....
1874	10,926,945	.....	.....	.....	.....	.....	.....	.....
1875	8,787,514	.....	.....	.....	.....	.....	.....	.....
1876	8,968,906	31,763	120,000	12,000	.....	.....	.....	.....
1877	13,135,475	29,888	172,000	13,000	.....	.....	.....	.....
1878	15,163,462	38,179	180,000	15,227	.....	.....	.....	.....
1879	19,685,176	29,112	180,000	19,858	.....	.....	.....	.....
1880	26,027,631	38,940	179,000	40,552	.....	.....	.....	.....
1881	27,376,509	33,867	151,000	99,862	.....	.....	.....	.....
1882	30,053,500	39,761	128,000	128,636	.....	.....	.....	.....
1883	23,128,389	47,632	126,000	142,857	4,755	.....	.....	.....
1884	23,772,209	90,081	90,000	262,000	4,148	.....	.....	.....
1885	20,776,041	661,580	91,000	325,000	5,164	.....	.....	.....
1886	25,798,000	1,782,970	102,000	377,145	4,726	.....	.....	.....
1887	22,356,193	5,022,632	145,000	678,572	4,791	76,295	.....	.....
1888	16,488,668	10,010,868	119,448	690,333	5,096	297,612	.....	.....
1889	21,487,435	12,471,466	544,113	303,220	5,400	316,476	33,375	1,460
1890	28,458,208	16,124,656	492,578	307,360	6,000	368,842	63,496	900
1891	33,009,236	17,740,301	2,406,218	323,600	9,000	665,482	136,634	675
1892	28,422,377	16,362,921	3,810,086	385,049	6,500	824,000	698,068	521
1893	20,314,513	16,249,769	8,445,412	470,179	3,000	594,390	2,335,293	400
1894	19,019,990	16,792,154	8,577,624	705,969	1,500	515,746	3,688,666	300
1895	19,144,390	19,545,283	8,120,125	1,206,482	1,500	438,232	4,386,182	200
1896	20,584,421	23,941,169	10,019,770	1,252,777	1,680	361,450	4,680,732	250
1897	19,262,066	21,560,515	13,090,045	1,903,411	322	384,934	4,122,356	500
1898	15,948,464	18,738,708	13,615,101	2,257,207	5,568	444,383	3,730,907	360
1899	14,374,512	21,142,108	13,910,630	2,642,095	18,280	390,278	3,848,182	360
1900	14,559,127	22,362,730	16,195,675	4,324,484	62,259	317,385	4,874,392	200
1901	13,831,996	21,648,083	14,177,126	8,786,330	137,259	460,520	5,757,086	250
1902	13,183,610	21,014,231	13,513,345	13,984,268	185,331	396,901	7,480,806	200
1903	12,518,134	20,480,286	12,899,395	24,382,472	554,286	483,925	9,186,411	.....
1904	12,239,026	18,876,631	12,644,686	29,649,434	998,284	501,763	11,339,124	.....
1905	11,554,777	16,346,660	11,578,110	33,427,473	1,217,337	376,238	10,964,247	181,084
1906	11,500,410	14,787,763	10,120,935	33,098,598	1,213,548	327,582	7,673,477	4,397,050
1907	11,211,606	12,207,448	9,095,296	39,748,375	820,844	331,851	5,128,037	24,281,973
1908	10,584,453	10,858,797	9,523,176	44,854,737	*f* 727,767	379,653	3,283,629	33,686,238
1909	10,434,300	10,632,793	10,745,092	55,471,601	*f* 639,016	310,861	2,296,086	30,898,339
1910	9,848,500	9,916,370	11,753,071	73,010,560	*f* 468,774	239,794	2,159,725	33,143,362
1911	9,200,673	8,817,112	9,795,464	81,134,391	*f* 472,458	226,926	1,695,289	31,317,038
1912	8,712,076	[a] 8,969,007	12,128,962	[g]87,272,593	*f* 484,368	206,052	970,009	28,601,308
1913	8,865,493	8,781,468	11,567,299	97,788,525	*f* 524,568	188,799	956,095	23,893,899
1914	9,109,309	8,536,352	9,680,033	99,775,327	*f* 502,441	222,773	1,335,456	21,919,749
1915	8,726,483	7,825,326	9,264,798	86,591,535	*f* 437,274	208,475	875,758	19,041,695
	762,906,696	440,587,330	269,497,613	827,865,094	9,533,244	10,857,618	103,699,558	261,368,311

[a] Includes the production of Michigan.
[b] Includes the production of Oklahoma.
[c] Included with Kansas.
[d] Estimated.
[e] Includes production of Utah.

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1859-1915, in barrels of 42 gallons.

Kansas.	Texas.	Missouri.	Oklahoma.	Wyoming.	Louisiana.	United States.	Total value.	Year.
Barrels.	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*		
.....	.....	.....	.....	.....	.....	2,000	$32,000	1859
.....	.....	.....	.....	.....	.....	500,000	4,800,000	1860
.....	.....	.....	.....	.....	.....	2,113,609	1,035,668	1861
.....	.....	.....	.....	.....	.....	3,056,690	3,209,525	1862
.....	.....	.....	.....	.....	.....	2,611,309	8,225,663	1863
.....	.....	.....	.....	.....	.....	2,116,109	20,996,576	1864
.....	.....	.....	.....	.....	.....	2,497,700	16,459,853	1865
.....	.....	.....	.....	.....	.....	3,597,700	13,455,398	1866
.....	.....	.....	.....	.....	.....	3,347,300	8,066,993	1867
.....	.....	.....	.....	.....	.....	3,646,117	13,217,174	1868
.....	.....	.....	.....	.....	.....	4,215,000	23,730,450	1869
.....	.....	.....	.....	.....	.....	5,260,745	20,503,754	1870
.....	.....	.....	.....	.....	.....	5,205,234	22,591,130	1871
.....	.....	.....	.....	.....	.....	6,293,194	21,440,503	1872
.....	.....	.....	.....	.....	.....	9,893,786	18,100,464	1873
.....	.....	.....	.....	.....	.....	10,926,945	12,647,527	1874
.....	.....	.....	.....	.....	.....	8,787,514	7,368,133	1875
.....	.....	.....	.....	.....	.....	9,132,669	22,982,822	1876
.....	.....	.....	.....	.....	.....	13,350,363	31,788,566	1877
.....	.....	.....	.....	.....	.....	15,396,868	18,044,520	1878
.....	.....	.....	.....	.....	.....	19,914,146	17,210,708	1879
.....	.....	.....	.....	.....	.....	26,286,123	24,600,638	1880
.....	.....	.....	.....	.....	.....	27,661,238	25,448,339	1881
.....	.....	.....	.....	.....	.....	30,349,897	23,631,165	1882
.....	.....	.....	.....	.....	.....	23,449,633	25,790,252	1883
.....	.....	.....	.....	.....	.....	24,218,438	20,595,966	1884
.....	.....	.....	.....	.....	.....	21,858,785	19,198,243	1885
.....	.....	.....	.....	.....	.....	28,064,841	19,996,313	1886
.....	.....	.....	.....	.....	.....	28,283,483	18,877,094	1887
.....	.....	.....	.....	.....	.....	27,612,025	17,947,620	1888
500	48	20	.....	.....	.....	35,163,513	26,963,340	1889
1,200	54	278	.....	.....	.....	45,823,572	35,365,105	1890
1,400	54	25	30	.....	.....	54,292,655	30,526,553	1891
5,000	45	10	80	.....	.....	50,514,657	25,906,463	1892
18,000	50	50	10	.....	.....	48,431,066	28,950,326	1893
40,000	60	8	130	2,369	.....	49,344,516	35,522,095	1894
44,430	50	10	37	3,455	.....	52,892,276	57,632,296	1895
113,571	1,450	43	170	2,878	.....	60,960,361	58,518,709	1896
81,098	65,975	19	625	3,650	.....	60,475,516	40,874,072	1897
71,980	546,070	10	.....	5,475	.....	55,364,233	44,193,359	1898
69,700	669,013	132	.....	5,560	.....	57,070,850	64,603,904	1899
74,714	836,089	[a] 1,602	6,472	5,450	.....	63,620,529	75,989,313	1900
179,151	4,393,658	[a] 2,335	10,000	5,400	.....	69,389,194	66,417,335	1901
331,749	16,083,658	[a] 757	37,100	6,253	548,617	88,766,916	71,178,910	1902
932,214	17,955,572	[a] 3,000	138,911	8,960	917,771	100,461,337	94,004,050	1903
4,250,779	22,241,413	[a] 2,572	1,366,748	11,542	2,958,958	117,080,960	101,175,455	1904
[b]12,013,495	28,136,189	[a] 3,100	[c]	8,454	8,910,416	134,717,580	84,157,399	1905
[b]21,718,648	12,567,897	[a] 3,500	[c]	[d] 7,000	9,077,528	126,493,936	92,444,735	1906
2,409,521	12,322,606	[a] 4,000	43,524,128	[e] 9,339	5,000,221	166,095,335	120,106,749	1907
1,801,781	11,206,464	[a] 15,246	45,798,765	[e] 17,775	5,788,874	178,527,355	129,079,184	1908
1,263,764	9,534,467	[a] 5,750	47,859,218	[e] 20,056	3,069,531	183,170,874	128,328,487	1909
1,128,668	8,899,266	[a] 3,615	52,028,718	[e] 115,430	6,841,395	209,557,248	127,899,688	1910
1,278,819	9,526,474	[a] 7,995	56,069,637	[e] 186,695	10,720,420	220,449,391	134,044,752	1911
1,592,796	11,735,057	([h])	51,427,071	1,572,306	9,263,439	222,935,044	164,213,247	1912
2,375,029	15,009,478	[i] 10,843	63,579,384	2,406,522	12,498,828	248,446,230	237,121,388	1913
3,103,585	20,068,184	[j] 7,792	73,631,724	3,560,375	14,309,435	265,762,535	214,125,215	1914
2,823,487	24,942,701	[j] 14,265	97,915,243	4,245,525	18,191,539	281,104,104	179,462,890	1915
57,725,079	228,742,082	86,977	533,394,201	12,210,469	108,086,972	3,616,561,244	2,971,388,126	

[f] No production in Tennessee recorded.
[g] Includes small production of Alaska.
[h] No production in Missouri; Michigan included in Ohio.
[i] Includes production of Alaska, Michigan, and New Mexico.
[j] Includes production of Alaska and Michigan.

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Petroleum marketed in the United States and average price per barrel in 1914 and 1915.

State.	1914			State.	1915		
	Quantity (barrels).	Value.	Average price per barrel.		Quantity (barrels).	Value.	Average price per barrel.
Alaska	(a)	(a)		Alaska	(a)	(a)	
California	99,775,327	$48,066,096	$0.482	California	86,591,535	$36,558,439	$0.422
Colorado	222,773	200,894	.902	Colorado	208,475	183,485	.880
Illinois	21,919,749	25,426,179	1.160	Illinois	19,041,695	18,655,850	.980
Indiana	1,335,456	1,548,042	1.159	Indiana	875,758	813,395	.929
Kansas	3,103,585	2,433,074	.784	Kansas	2,823,487	1,702,891	.603
Kentucky	502,441	498,556	.992	Kentucky	437,274	418,357	.957
Louisiana	14,309,435	12,886,897	.901	Louisiana	18,191,539	10,804,653	.594
Michigan	(a)	(a)		Michigan	(a)	(a)	
Missouri	(a)	(a)		Missouri	(a)	(a)	
New York	938,974	1,760,868	1.875	New York	887,778	1,390,325	1.566
Ohio	8,536,352	13,372,729	1.567	Ohio	7,825,326	10,061,493	1.286
Oklahoma	73,631,724	57,253,187	.778	Oklahoma	97,915,243	56,706,133	.579
Pennsylvania	8,170,335	15,573,822	1.906	Pennsylvania	7,838,705	12,431,353	1.586
Texas	20,068,184	14,942,848	.745	Texas	24,942,701	13,026,925	.522
West Virginia	9,680,033	18,468,540	1.908	West Virginia	9,264,798	14,468,278	1.561
Wyoming	3,560,375	1,679,192	.472	Wyoming	4,245,525	2,217,018	.522
Other States	b 7,792	b 14,291	1.834	Other States	b 14,265	b 24,295	1.703
	265,762,535	214,125,215	.806		281,104,104	179,462,890	.638

a Included in "Other States." b Includes Alaska, Michigan, and Missouri.

Increase or decrease in quantity of petroleum marketed in 1915 compared with 1914.

State.	Marketed production (barrels).		Increase.		Decrease.	
	1914	1915	Barrels.	Per cent.	Barrels.	Per cent.
Alaska	(a)	(a)				
California	99,775,327	86,591,535			13,183,792	13.21
Colorado	222,773	208,475			14,298	6.42
Illinois	21,919,749	19,041,695			2,878,054	13.13
Indiana	1,335,456	875,758			459,698	34.42
Kansas	3,103,585	2,823,487			280,098	9.02
Kentucky	502,441	437,274			65,167	12.97
Louisiana	14,309,435	18,191,539	3,882,104	27.13		
Michigan	(a)	(a)				
Missouri	(a)	(a)				
New York	938,974	887,778			51,196	5.45
Ohio	8,536,352	7,825,326			711,026	8.33
Oklahoma	73,631,724	97,915,243	24,283,519	32.98		
Pennsylvania	8,170,335	7,838,705			331,630	4.06
Texas	20,068,184	24,942,701	4,874,517	24.29		
West Virginia	9,680,033	9,264,798			415,235	4.30
Wyoming	3,560,375	4,245,525	685,150	19.24		
Other States	b 7,792	b 14,265	6,473	83.07		
	265,762,535	281,104,104	15,341,569	5.77		

a Included in "Other States." b Includes Alaska, Michigan, and Missouri.

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RANK OF OIL-PRODUCING STATES.

QUANTITY.

The most significant change in rank among the oil-producing States was that affecting Oklahoma and California, the former superseding the latter in first place by a margin of more than 11,000,000 barrels. Next in importance was the advance of Texas from fourth place in 1914 to third in 1915, by exchange with Illinois. Farther down the line Pennsylvania advanced to seventh place and Ohio fell back to eighth. Among the States of less importance there were minor changes of no particular significance.

Rank of petroleum-producing States based on quantity of oil marketed, 1914 and 1915.

State.	1914			State.	1915		
	Rank.	Quantity (barrels).	Percentage.		Rank.	Quantity (barrels).	Percentage.
California	1	99,775,327	37.54	Oklahoma	1	97,915,243	34.83
Oklahoma	2	73,631,724	27.71	California	2	86,591,535	30.81
Illinois	3	21,919,749	8.25	Texas	3	24,942,701	8.87
Texas	4	20,068,184	7.55	Illinois	4	19,041,095	6.77
Louisiana	5	14,309,435	5.39	Louisiana	5	18,191,539	6.47
West Virginia	6	9,680,023	3.64	West Virginia	6	9,264,798	3.30
Ohio	7	8,536,352	3.21	Pennsylvania	7	7,838,705	2.79
Pennsylvania	8	8,170,335	3.07	Ohio	8	7,825,326	2.78
Wyoming	9	3,560,375	1.34	Wyoming	9	4,245,525	1.51
Kansas	10	3,103,585	1.17	Kansas	10	2,823,487	1.00
Indiana	11	1,335,456	.50	New York	11	887,778	.32
New York	12	938,974	.35	Indiana	12	875,758	.31
Kentucky	13	502,441	.19	Kentucky	13	437,374	.16
Colorado	14	222,773	.09	Colorado	14	208,475	.08
Alaska	15	7,792		Alaska	15	14,265	
Michigan	16			Missouri	16		
Missouri	17			Michigan	17		
		265,762,535	100.00			281,104,104	100.00

VALUE.

Changes in rank, based on the value of the petroleum marketed in 1915, affected Texas, Illinois, Pennsylvania, and Ohio, and were due to the same conditions that necessitated their changes of rank in the tabulation by quantity.

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Rank of petroleum-producing States based on value of oil marketed, 1914 and 1915.

State.	1914			State.	1915		
	Rank.	Value.	Percentage.		Rank.	Value.	Percentage.
Oklahoma	1	$57,253,187	26.74	Oklahoma	1	$56,706,133	31.60
California	2	48,066,096	22.45	California	2	36,558,439	20.37
Illinois	3	25,426,179	11.87	Illinois	3	18,655,850	10.40
West Virginia	4	18,468,540	8.63	West Virginia	4	14,468,278	8.06
Pennsylvania	5	15,573,822	7.27	Texas	5	13,026,925	7.26
Texas	6	14,942,848	6.98	Pennsylvania	6	12,431,353	6.93
Ohio	7	13,372,729	6.25	Louisiana	7	10,804,653	6.02
Louisiana	8	12,886,807	6.02	Ohio	8	10,061,493	5.61
Kansas	9	2,433,074	1.14	Wyoming	9	2,217,018	1.24
New York	10	1,760,868	.82	Kansas	10	1,702,891	.95
Wyoming	11	1,679,192	.78	New York	11	1,390,325	.77
Indiana	12	1,548,042	.72	Indiana	12	813,395	.45
Kentucky	13	498,556	.23	Kentucky	13	418,357	.23
Colorado	14	200,894	.09	Colorado	14	183,485	.10
Alaska	15			Alaska	15		
Missouri	16	14,291	.01	Missouri	16	24,295	.01
Michigan	17			Michigan	17		
		214,125,215	100.00			179,462,890	100.00

WORLD'S PRODUCTION OF PETROLEUM.

The following table shows the production of petroleum in the principal oil-producing countries of the world in 1915, in barrels and metric tons, with percentage of the total contributed by each country for the year, together with the total production credited to each country from 1857 to 1915, inclusive, with percentage of the grand total contributed by each country:

World's production of crude petroleum in 1915 and since 1857, by countries.

Country.	Production, 1915.			Total production, 1857–1915.		
	Barrels of 42 gallons.	Metric tons.	Percentage of total.	Barrels of 42 gallons.	Metric tons.	Percentage of total.
United States	[a] 281,104,104	[a] 37,480,547	65.73	[a] 3,616,561,244	[a] 482,208,266	60.09
Russia	68,548,062	9,353,077	16.03	1,690,781,907	222,984,256	28.09
Mexico	32,910,808	4,388,068	7.69	123,270,377	16,420,008	2.05
Dutch East Indies [b]	12,386,808	1,710,445	2.90	148,999,921	20,087,089	2.48
Roumania	12,029,913	1,673,145	2.81	130,012,387	17,477,878	2.16
India	8,202,674	1,093,690	1.92	81,592,385	10,878,984	1.36
Galicia	4,158,899	578,388	.97	136,032,500	18,918,364	2.26
Japan and Formosa	3,118,464	415,785	.73	30,169,622	4,022,606	.50
Peru	2,487,251	331,633	.58	16,794,223	2,239,229	.28
Germany	995,764	[c] 140,000	.23	13,961,333	1,875,974	.23
Trinidad	[c] 750,000	100,000	.18	2,819,430	375,924	.05
Argentina	516,120	75,900	.12	1,033,121	151,093	.02
Egypt	221,768	29,569	.05	1,308,496	174,466	.02
Canada	215,464	28,729	.05	23,709,074	3,161,210	.39
Italy	39,548	[c] 5,500	.01	842,020	119,279	.01
Other countries	[c] 10,000	1,333		372,000	49,600	.01
	427,695,347	57,405,809	100.00	6,018,260,040	801,145,676	100.00

[a] Marketed production. [b] Includes British Borneo. [c] Estimated.

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The most significant change in rank among the oil-producing countries of the world in 1915 was the advance of the Dutch East Indies to fourth place and the corresponding recession of Roumania to fifth place. Of the countries producing relatively small quantities of petroleum the falling off in production that reduced Egypt from eleventh to thirteenth place, the increase that advanced Trinidad from twelfth to eleventh place, and the increase that warranted the advancement of Argentina from "Other countries" to twelfth place are worthy of notice.

Although the total quantity of petroleum marketed in the United States in 1915 was about 6 per cent greater than in 1914, the increase in the total world's production was about 7 per cent. As a consequence the relative proportion of the world's production contributed by the United States showed a decline amounting to about one-half of 1 per cent compared with 1914.

The distribution of the world's production of petroleum since 1857 is shown in the following table, and the relative importance of the United States as an annual contributor to this output since 1859 is shown graphically in the diagram on page 572 (fig. 25).

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World's production of crude petroleum since 1857,

Year.	Roumania.	United States.[a]	Italy.	Canada.	Russia.	Galicia.	Japan and Formosa.	Germany.
1857	1,977	.....	.....	.....	.....	.....	.....	.....
1858	3,560	.....	.....	.....	.....	.....	.....	.....
1859	4,349	2,000	.....	.....	.....	.....	.....	.....
1860	8,542	500,000	36	.....	.....	.....	.....	.....
1861	17,279	2,113,609	39	.....	.....	.....	.....	.....
1862	23,198	3,056,690	29	11,775	.....	.....	.....	.....
1863	27,943	2,611,309	58	82,814	40,816	.....	.....	.....
1864	33,013	2,116,109	72	90,000	64,586	.....	.....	.....
1865	39,017	2,497,700	2,265	110,000	66,542	.....	.....	.....
1866	42,534	3,597,700	992	175,000	83,052	.....	.....	.....
1867	50,838	3,347,300	791	190,000	119,917	.....	.....	.....
1868	55,369	3,646,117	367	200,000	88,327	.....	.....	.....
1869	58,533	4,215,000	144	220,000	202,308	.....	.....	.....
1870	83,765	5,260,745	86	250,000	204,618	.....	.....	.....
1871	90,090	5,205,234	273	269,397	165,129	.....	.....	.....
1872	91,251	6,293,194	331	306,100	184,391	.....	.....	.....
1873	104,096	9,893,736	467	365,052	474,379	.....	.....	.....
1874	103,177	10,926,945	604	168,807	563,751	149,837	.....	.....
1875	108,569	8,787,514	813	220,000	697,364	158,522	4,566	.....
1876	111,314	9,132,669	2,891	312,000	1,320,528	164,157	7,708	.....
1877	108,569	13,350,363	2,934	312,000	1,800,720	169,792	9,560	.....
1878	109,300	15,396,868	4,329	312,000	2,400,960	175,420	17,884	.....
1879	110,007	19,914,146	2,891	575,000	2,761,104	214,800	23,457	.....
1880	114,321	26,286,123	2,035	350,000	3,001,200	229,120	25,497	9,310
1881	121,511	27,661,238	1,287	275,000	3,601,441	286,400	16,751	39,219
1882	136,610	30,349,897	1,316	275,000	4,537,815	330,076	15,549	58,025
1883	139,496	23,449,633	1,618	250,000	6,002,401	365,160	20,473	26,708
1884	210,667	24,218,438	2,855	250,000	10,804,577	408,120	27,928	46,161
1885	193,411	21,858,785	1,941	250,000	13,924,596	465,400	29,287	41,360
1886	168,606	28,064,841	1,575	584,061	18,006,407	305,884	37,916	73,864
1887	181,907	28,283,483	1,496	525,655	18,367,781	343,832	28,645	74,284
1888	218,576	27,612,025	1,251	695,203	23,048,787	466,537	37,436	84,782
1889	297,666	35,163,513	1,273	704,390	24,609,407	515,268	52,811	68,217
1890	383,227	45,823,572	2,998	795,030	28,691,218	659,012	51,420	108,296
1891	488,201	54,292,655	8,305	755,298	34,573,181	630,730	52,917	108,929
1892	593,175	50,514,657	18,321	779,753	35,774,504	646,220	68,901	101,404
1893	535,655	48,431,066	19,069	798,406	40,456,519	692,669	106,384	99,390
1894	507,255	49,344,516	20,552	829,104	36,375,428	949,146	171,744	122,564
1895	575,200	52,892,276	25,843	726,138	46,140,174	1,452,999	141,310	121,277
1896	543,348	60,960,361	18,149	726,822	47,220,633	2,443,080	197,082	145,061
1897	570,886	60,475,516	13,892	709,857	54,399,568	2,226,368	218,559	165,745
1898	776,238	55,364,233	14,489	758,391	61,609,357	2,376,108	265,389	183,427
1899	1,425,777	57,070,850	16,121	808,570	65,954,968	2,313,047	536,079	192,232
1900	1,628,535	63,620,529	12,102	913,498	75,779,417	2,346,505	866,814	358,297
1901	1,678,320	69,389,194	16,150	756,679	85,168,556	3,251,544	1,110,790	313,630
1902	2,059,935	88,766,916	18,933	530,624	80,540,044	4,142,159	1,193,088	353,674
1903	2,763,117	100,461,337	17,876	486,637	75,591,256	5,234,475	1,209,371	445,818
1904	3,599,026	117,080,960	25,476	552,575	78,536,655	5,947,383	1,419,473	637,431
1905	4,420,987	134,717,580	44,027	634,095	54,960,270	5,765,317	1,472,804	560,963
1906	6,378,184	126,493,936	53,577	569,753	58,897,311	5,467,967	1,710,768	578,610
1907	8,118,207	166,095,335	59,875	788,872	61,350,734	8,455,841	2,001,838	756,631
1908	8,252,157	178,527,355	50,966	527,987	62,186,447	12,612,295	2,070,145	1,009,278
1909	9,327,278	183,170,874	42,388	420,755	65,970,350	14,932,799	1,889,563	1,018,837
1910	9,723,808	209,557,248	50,830	315,895	70,336,574	12,673,688	1,930,661	1,032,522
1911	11,107,450	220,449,391	74,709	291,096	66,183,691	10,519,270	1,658,903	1,017,045
1912	12,976,232	222,935,044	53,778	243,336	68,019,208	8,535,174	1,671,405	1,081,060
1913	13,554,768	248,446,230	47,198	228,080	62,834,356	7,818,130	1,942,009	[b] 995,764
1914	12,826,579	265,762,535	39,849	214,805	67,020,522	[b] 5,033,350	2,738,378	[b] 995,764
1915	12,029,913	281,104,104	[b] 39,548	215,464	68,548,062	4,158,899	3,118,464	[b] 995,764
	130,012,387	3,616,561,244	842,020	23,709,074	1,690,781,907	136,082,500	30,169,622	13,961,333

[a] Marketed production. [b] Estimated.

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by years and countries, in barrels of 42 gallons.

India.	Dutch East Indies.	Peru.	Mexico.	Argentina.	Trinidad.	Egypt.	Other countries.	Total.	Year.
.....	.....	.....	.....	.....	.....	.....	.....	1,977	1857
.....	.....	.....	.....	.....	.....	.....	.....	3,560	1858
.....	.....	.....	.....	.....	.....	.....	.....	6,349	1859
.....	.....	.....	.....	.....	.....	.....	.....	506,578	1860
.....	.....	.....	.....	.....	.....	.....	.....	2,130,917	1861
.....	.....	.....	.....	.....	.....	.....	.....	3,091,092	1862
.....	.....	.....	.....	.....	.....	.....	.....	2,762,940	1863
.....	.....	.....	.....	.....	.....	.....	.....	2,308,780	1864
.....	.....	.....	.....	.....	.....	.....	.....	2,715,524	1865
.....	.....	.....	.....	.....	.....	.....	.....	3,899,278	1866
.....	.....	.....	.....	.....	.....	.....	.....	3,708,846	1867
.....	.....	.....	.....	.....	.....	.....	.....	3,990,180	1868
.....	.....	.....	.....	.....	.....	.....	.....	4,595,985	1869
.....	.....	.....	.....	.....	.....	.....	.....	5,799,214	1870
.....	.....	.....	.....	.....	.....	.....	.....	5,730,063	1871
.....	.....	.....	.....	.....	.....	.....	.....	6,877,267	1872
.....	.....	.....	.....	.....	.....	.....	.....	10,857,720	1873
.....	.....	.....	.....	.....	.....	.....	.....	11,983,121	1874
.....	.....	.....	.....	.....	.....	.....	.....	9,977,348	1875
.....	.....	.....	.....	.....	.....	.....	.....	11,051,267	1876
.....	.....	.....	.....	.....	.....	.....	.....	15,753,938	1877
.....	.....	.....	.....	.....	.....	.....	.....	18,416,761	1878
.....	.....	.....	.....	.....	.....	.....	.....	23,601,405	1879
.....	.....	.....	.....	.....	.....	.....	.....	30,017,606	1880
.....	.....	.....	.....	.....	.....	.....	.....	31,992,797	1881
.....	.....	.....	.....	.....	.....	.....	.....	35,704,288	1882
.....	.....	.....	.....	.....	.....	.....	.....	30,255,479	1883
.....	.....	.....	.....	.....	.....	.....	.....	35,968,741	1884
.....	.....	.....	.....	.....	.....	.....	.....	36,764,730	1885
.....	.....	.....	.....	.....	.....	.....	.....	47,243,154	1886
.....	.....	.....	.....	.....	.....	.....	.....	47,807,063	1887
.....	.....	.....	.....	.....	.....	.....	.....	52,164,597	1888
94,250	.....	.....	.....	.....	.....	.....	.....	61,507,095	1889
118,065	.....	.....	.....	.....	.....	.....	.....	76,632,838	1890
190,131	.....	.....	.....	.....	.....	.....	.....	91,100,347	1891
242,284	.....	.....	.....	.....	.....	.....	.....	88,739,219	1892
298,960	600,000	.....	.....	.....	.....	.....	.....	92,088,127	1893
327,218	688,170	.....	.....	.....	.....	.....	.....	89,335,697	1894
371,536	1,215,757	.....	.....	.....	.....	.....	.....	103,662,510	1895
429,979	1,427,132	47,536	.....	.....	.....	.....	.....	114,159,183	1896
545,704	2,551,649	70,831	.....	.....	.....	.....	.....	121,948,575	1897
542,110	2,964,035	70,905	.....	.....	.....	.....	.....	124,924,682	1898
940,971	1,795,961	89,166	.....	.....	.....	.....	.....	131,143,742	1899
1,078,264	2,253,355	274,800	.....	.....	.....	.....	.....	149,132,116	1900
1,430,716	4,013,710	274,880	.....	.....	.....	.....	[b] 20,000	167,424,089	1901
1,617,363	2,430,465	286,725	.....	.....	.....	.....	[b] 26,000	181,965,876	1902
2,510,289	5,770,056	278,092	.....	.....	.....	.....	[b] 36,000	194,804,294	1903
2,385,468	6,508,435	345,834	220,653	.....	.....	.....	[b] 40,000	218,299,419	1904
4,137,098	7,849,890	447,880	320,379	.....	.....	.....	[b] 30,000	215,361,296	1905
4,015,803	8,180,057	536,294	1,097,264	.....	.....	.....	[b] 30,000	214,010,124	1906
4,344,162	9,982,597	756,226	1,717,690	101	.....	.....	[b] 30,000	264,956,109	1907
5,047,038	10,263,357	1,011,180	3,481,610	11,472	160	.....	[b] 30,000	285,101,456	1908
6,676,517	11,041,852	1,316,118	2,488,742	18,431	57,143	.....	[b] 20,000	298,391,647	1909
6,137,990	11,080,620	1,330,105	3,332,807	20,753	142,857	.....	[b] 20,000	327,636,356	1910
6,451,203	12,172,949	1,368,274	14,051,643	13,119	285,307	9,150	[b] 20,000	345,673,200	1911
7,116,672	10,845,624	1,751,143	16,558,215	47,007	436,805	205,905	[b] 20,000	382,446,598	1912
7,980,149	11,172,294	2,133,261	25,902,439	130,618	503,616	94,635	[b] 20,000	383,753,547	1913
7,409,702	[c] 11,834,492	1,917,802	21,188,427	275,500	643,533	777,038	[b] 20,000	396,698,366	1914
8,202,674	[c] 12,386,808	2,487,251	32,910,506	516,120	[b] 750,000	221,768	[b] 10,000	427,695,347	1915
81,592,385	148,999,921	16,794,223	123,270,377	1,033,121	2,819,430	1,308,496	372,000	6,018,260,040	

[c] Includes British Borneo.

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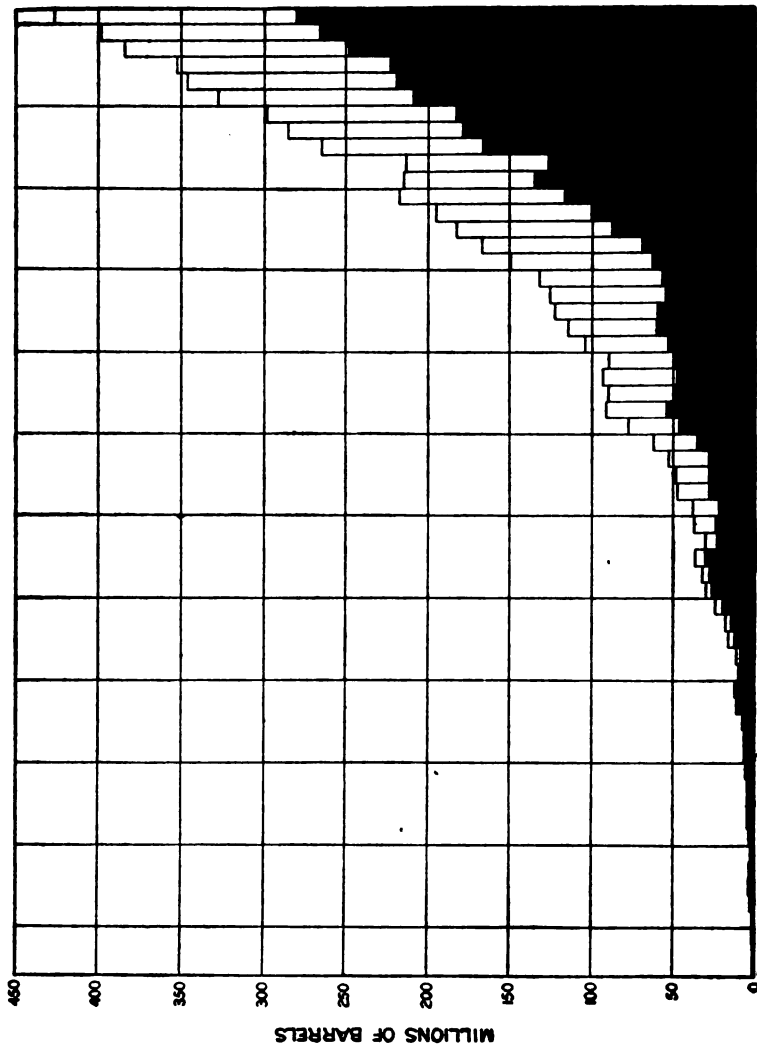

FIGURE 25.—Graphic chart showing world's production of crude petroleum, 1857–1915, inclusive, and the proportion contributed annually by the United States (indicated in black).

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CLASSIFICATION BY FIELDS.

For convenience of discussion the oil pools of the United States are grouped in certain major areas or fields based originally on geographic position alone. As these fields have been extended areally, the geographic boundaries have become in many cases less distinct, and the separation has come to be based more and more on fundamental differences in the type of oil produced and its adaptability to refining needs. Thus the oils of the Appalachian field are in the main of paraffin base, free from asphalt and objectionable sulphur, and they yield by ordinary refining methods high percentages of gasoline and illuminating oils—the products in greatest demand. Contrasted with them is the petroleum of the Lima-Indiana field, which contains some asphalt, though consisting chiefly of paraffin hydrocarbons, and is contaminated with sulphur compounds which necessitate special treatment for their elimination.

Illinois oils contain varying proportions of both asphalt and paraffin and differ considerably as to specific gravity and distillation products. Sulphur is generally present but rarely in such form as to necessitate special treatment for its removal.

Mid-Continent oils vary in composition within wide limits, ranging from asphaltic oils, poor in gasoline and illuminants, to oils in which the asphalt content is negligible and the paraffin content relatively high and which yield correspondingly high percentages of the lighter products on distillation. Sulphur is present in varying quantities in the lower grade oils, in certain of which—Healdton grade, for example—it exists in the form requiring special treatment for its elimination.

Oils from the Gulf field are characterized by relatively high percentages of asphalt and low percentages of the lighter gravity distillation products. Considerable sulphur is present, much of which, however, is in the form of sulphureted hydrogen and is easily removed by steam before refining or utilizing the oil as fuel.

Oils from Wyoming and Colorado are in the main of paraffin base, suitable for refining by ordinary methods. Heavy asphaltic oils of fuel grade are also obtained in certain of the Wyoming fields. The California oils are generally characterized by much asphalt and little or no paraffin and by varying proportions of sulphur. The chief products are fuel oils, lamp oils, lubricants, and oil asphalt, though low percentages of naphthas may be derived from certain of the lighter oils, notably those of the Santa Maria, Sespe, and Santa Paula fields, in the southern part of the State.

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MARKETED PRODUCTION.

Petroleum marketed in the United States in 1914 and 1915, by fields.

Field.	1914			1915		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
Appalachian	24,101,048	$45,239,201	$1.877	22,860,048	$35,468,973	$1.552
Lima-Indiana	5,062,543	5,963,356	1.182	4,269,591	4,114,228	.964
Illinois	21,919,749	25,426,179	1.160	19,041,695	18,655,350	.980
Mid-Continent	97,995,400	78,671,902	.803	123,295,867	72,437,701	.588
Gulf	13,117,528	8,844,104	.674	20,577,103	9,802,901	.476
California	99,775,327	48,066,096	.482	86,591,535	36,558,439	.422
Colorado and Wyoming	3,783,148	1,880,086	.497	4,454,000	2,400,503	.539
Other fields	[a] 7,792	[a] 14,291	1.834	[a] 14,265	[a] 24,295	1.703
	265,762,535	214,125,215	.806	281,104,104	179,462,390	.638

[a] Includes Alaska, Michigan, and Missouri.

Petroleum marketed in the United States in 1914 and 1915, by fields, with percentage of increase or decrease.

Field.	Marketed production (barrels).		Increase.		Decrease.	
	1914	1915	Barrels.	Per cent.	Barrels.	Per cent.
Appalachian	24,101,048	22,860,048	.....	.....	1,241,000	5.15
Lima-Indiana	5,062,543	4,269,591	.....	.....	792,952	15.66
Illinois	21,919,749	19,041,695	.....	.....	2,878,054	13.13
Mid-Continent	97,995,400	123,295,867	25,300,467	25.82	.....	.....
Gulf	13,117,528	20,577,103	7,459,575	56.81	.....	.....
California	99,775,327	86,591,535	.....	.....	13,183,792	13.21
Colorado and Wyoming	3,783,148	4,454,000	670,852	17.73	.....	.....
Other fields	[a] 7,792	[a] 14,265	6,473	83.07	.....	.....
	265,762,535	281,104,104	15,341,569	5.77	.....	.....

[a] Includes Alaska, Michigan, and Missouri.

Petroleum marketed in the United States, 1911–1915, by fields, in barrels.

Field.	1911	1912	1913	1914	1915
Appalachian	23,749,832	26,338,516	25,921,785	24,101,048	22,860,048
Lima-Indiana	6,231,164	[a] 4,925,906	4,773,138	5,062,543	4,269,591
Illinois	31,317,038	28,601,308	23,893,899	21,919,749	19,041,695
Mid-Continent	66,595,477	65,473,345	84,920,225	97,995,400	123,295,867
Gulf	10,999,873	8,545,018	8,542,494	13,117,528	20,577,103
California	81,134,391	[b] 87,272,593	97,788,525	99,775,327	86,591,535
Colorado and Wyoming	[c] 421,616	1,778,358	2,595,321	3,783,148	4,454,000
Other fields	.....	.....	[d] 10,843	[e] 7,792	[e] 14,265
	220,449,391	222,935,044	248,446,230	265,762,535	281,104,104

[a] Includes Michigan.
[b] Includes Alaska.
[c] Includes Michigan and Missouri.
[d] Includes Alaska, Michigan, Missouri, and New Mexico.
[e] Includes Alaska, Michigan, and Missouri.

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Percentages of petroleum marketed in the several fields, 1911–1915.

Field.	1911	1912	1913	1914	1915
Appalachian	10.77	11.81	10.430	9.07	8.13
Lima-Indiana	2.83	2.21	1.930	1.90	1.52
Illinois	14.21	12.83	9.620	8.25	6.77
Mid-Continent	30.21	29.37	34.180	36.87	43.86
Gulf	4.99	3.83	3.440	4.94	7.32
California	36.80	39.15	39.356	37.54	30.81
Colorado and Wyoming	.19	.80	1.040	1.43	1.585
Other fields			.004		.005
	100.00	100.00	100.000	100.00	100.00

DELIVERIES.

Petroleum delivered to trade in 1914 and 1915, by fields, in barrels.

Field.	1914			1915		
	Refining.	Fuel.	Total.	Refining.	Fuel.	Total.
Appalachian	a22,994,777		22,994,777	b22,843,247		22,843,247
Lima-Indiana	5,149,155	c 11,128	5,160,283	2,995,922	3,636	2,999,558
Illinois	16,589,703	d 9,724	16,599,427	21,246,359	e 31,065	21,277,424
Kansas-Oklahoma	f72,122,979	335,668	72,458,647	g90,520,272	1,288,178	91,808,450
Louisiana	13,481,837	887,208	14,369,045	13,357,805	1,884,119	15,241,924
Texas	h14,227,235	4,727,185	18,954,420	15,540,527	4,744,685	20,285,212
California	50,829,203	41,587,530	92,416,733	57,037,769	40,626,668	97,664,437
Colorado and Wyoming	h4,010,643	51,421	4,054,272	3,998,380	281,286	4,265,401
Other fields			7,792			14,265
	199,405,532	47,609,864	247,015,396	227,540,281	48,859,637	276,399,918

a Includes 44,318 barrels of lubricating oil.
b Includes 61,805 barrels of lubricating oil.
c Includes 116 barrels used for street sprinkling.
d Includes 1,542 barrels used for hog dip and street sprinkling.
e Includes 725 barrels used for hog dip and street sprinkling.
f Includes 4,766,409 barrels shipped by rail that can not be classified.
g Includes 467,458 barrels shipped by rail that can not be classified.
h Includes small amount of lubricating oil.

STOCKS AND STORAGE.

The reserve of petroleum aboveground in the United States is the working stock from which the refining industry draws its supply, and fluctuations in this reserve normally have considerable influence on the market price of crude oil. When conditions of production are such that this reserve is steadily increasing a decline in market prices for crude petroleum may be expected. When, however, requisitions become necessary to keep the refineries operating to capacity, prices of oil in the field tend to advance and stimulate additional drilling.

This reserve is distributed among several classes of holders, the bulk, however, being in the custody of the large pipe-line companies engaged in interstate transportation of petroleum. Additional quantities are held in tanks and reservoirs in or adjacent to productive fields and at the various refineries throughout the country.

No statistics are available to show the aggregate quantity of this reserve.

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PIPE-LINE STOCKS.

The statistics tabulated below show the quantities of petroleum of various grades in the custody of the pipe-line companies of the United States at the close of business on December 31, and include the stocks held by certain producing and purchasing companies that conducted a pipe-line business at the beginning of 1915 which was subsequently operated by a separate organization.

The following table summarizes the reserves of crude petroleum held by pipe-line companies at the close of 1914 and 1915:

Stocks of all grades of petroleum at the end of 1914 and 1915, in barrels.

Grade of oil.	Held by eastern pipe lines and refineries.[a]		In pipe-line storage outside of eastern field.		Total.		Increase.	Decrease.
	1914	1915	1914	1915	1914	1915		
Pennsylvania[b]	5,436,576	5,488,553	.....	.....	5,436,576	5,488,553	51,977	.....
Lima	1,648,615	2,918,648	.....	.....	1,648,615	2,918,648	1,270,033	.....
Illinois[c]	1,016,937	1,550,703	12,546,806	9,777,311	13,563,743	11,328,014	.....	2,235,729
Kentucky	288,119	252,943	.....	.....	288,119	252,943	.....	35,176
Kansas, Oklahoma	2,772,821	2,710,207	55,253,098	64,945,992	58,025,919	66,956,199	8,930,280	.....
Texas	.....	.....	4,944,055	9,601,544	4,944,055	9,601,544	4,657,489	.....
Louisiana	.....	.....	1,811,464	4,761,079	1,811,464	4,761,079	2,949,615	.....
California	.....	.....	55,660,986	44,588,084	55,660,986	44,588,084	.....	11,072,902
Colorado and Wyoming	.....	.....	170,292	358,891	170,292	358,891	188,599	.....
	11,163,068	12,921,054	130,386,701	133,332,901	141,549,769	146,253,955	4,704,186	.....

[a] These pipe lines connect with the delivering lines of the Illinois, Kansas, and Oklahoma fields and receive and transfer large quantities of these western oils to the Atlantic seaboard in addition to the oil from wells directly tributary to their own systems.
[b] Includes natural lubricating oil from Pennsylvania and West Virginia.
[c] Includes some Indiana oil of Illinois grade.

FIELD STORAGE.

The table presented below represents the results of the first year's effort on the part of the Geological Survey to obtain statistics of the quantity of crude petroleum held in field tanks and reservoirs by the producers. The statistics are admittedly incomplete but the quantities stated are believed to represent the true situation with fair accuracy.

Petroleum in field storage at end of 1915.

	Barrels.		Barrels.
Appalachian field	802,000	Colorado and Wyoming field	177,000
Lima-Indiana field	82,000	California field	12,396,000
Illinois field	258,000		
Mid-Continent field	34,114,000		47,931,000
Gulf coast field	102,000		

The relations between monthly quantity of oil marketed, pipe-line stocks, prices of crude oil at the well, and of the principal refinery product—gasoline—at the point of consumption (or as near it as consistent quotations are available) in the eastern and Mid-Continent fields are shown graphically in the accompanying diagram (Pl. V).

The coincidence between diminishing stocks and advancing prices for crude oil and refinery products is well shown in the period from 1911 to 1913, as is the reverse condition in the period from 1909 to

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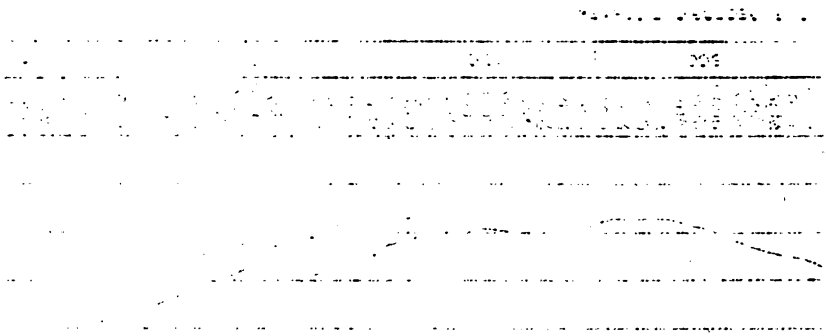

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1911, and in 1914. In 1915, however, anomalies appear which tend to indicate that prices of crude oil and of refinery products in greatest immediate demand are less responsive to the law of supply and demand for crude petroleum than formerly.

With the average monthly production greater than ever before, with pipe-line stocks at a level comparable with 1909 and 1910, when prices of Pennsylvania grade were steadily declining to $1.30 a barrel, and with field storage at a maximum, the rapid and extraordinary rise in prices both of crude oil and of gasoline that took place during the closing months of 1915 seems to require some other explanation than a shortage of crude petroleum. This explanation is believed to lie in part in the large increase in refining capacity, particularly in the Mid-Continent field, in 1914 and 1915, which would logically warrant some increase in surface reserves of oil; in part in a steadily expanding market for motor fuels, the influence of which would naturally be to appreciate values of the highest grade crudes; and in part in the fact that the bulk of the pipe-line stocks was owned by a few financially strong companies that were in a position to enter the Cushing field and buy up the greater part of the field storage when prices were at their lowest.

With the latter companies a shortage of crude was by no means imminent, though their action in promptly purchasing these stocks and withdrawing them from the open market paved the way for active competition for the current production on the part of smaller refiners, less favored with transportation and storage facilities. This competition provided a basis for advancing the price of high-grade crude, and as the small refiners were compelled to make expenses or go out of business, they were forced to meet the advancing price of crude material by increasing the price of the product in greatest demand. The attitude of the larger companies in acquiescing in the advances in price of refined products can be readily understood in the light of the fact that they undoubtedly realized their inability to supply the market for these products were their smaller competitors to go out of business, of the additional fact that their profits were destined to increase with every advance in the price of refinery products because of their possession of crude reserves purchased at rock-bottom prices, and of the further fact that these reserves of crude oil were thus steadily appreciating in value.

The highly advantageous position of the stronger companies as a result of this combination of circumstances has been well recognized throughout the petroleum industry and as a consequence the early months of 1916 have witnessed a remarkable advance in the movement already mentioned toward the consolidation under a single management of a great number of formerly independent producing and refining interests, especially in the Mid-Continent region.

FUTURE SUPPLY OF PETROLEUM.

A periodic accounting of the quantities of petroleum removed from nature's storehouse is of unquestioned value, but its full force is lost unless some knowledge is had of the quantity of petroleum remaining in the ground.

The fluid nature of petroleum and the mode of its occurrence in rock structures that often disclose no surface evidence of their pres-

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ence are factors which render exact computations of petroleum reserves impossible and render estimates of future supplies peculiarly hazardous.

As to the potentialities of the oil-producing areas of the United States, no better measure is believed to exist than the estimate furnished in February, 1916, by the Secretary of the Interior to Congress in response to a resolution of the Senate asking for certain pertinent data bearing on the production, consumption, and price of gasoline. This estimate, which has behind it the knowledge and experience of about 30 petroleum geologists of the United States Geological Survey, is assuredly conservative and is the result of probably the most thorough study of the subject that has ever been made. The following table, prepared for Senate Document 310, shows the quantity of petroleum already produced and the estimated future production of the known and prospective oil fields of the United States:

Actual production and possible future supply of petroleum in the United States.

Field.	Production, 1859–1915.		Possible future production (millions of barrels).
	Millions of barrels.	Estimated percentage of total exhaustion.	
Appalachian	1,150	70	481
Lima-Indiana	438	93	31
Illinois	251	51	244
Kansas-Oklahoma	617	25	1,874
North Texas	44	8	484
Northwest Louisiana	58	22	124
Gulf coast	236	13	1,500
Colorado	11	65	6
Wyoming-Montana	12	2	540
California	835	26	2,345
	3,652	32	7,629

SUMMARY OF WELLS DRILLED.

The following tables, compiled from trade-journal sources, with the exception of the statistics for Alaska, California, Colorado, Wyoming, Utah, Michigan, and miscellaneous, which are taken from reports by the oil producers themselves, show in condensed form the results of drilling activity in the United States in the last two years:

Wells drilled in the United States in 1914 and 1915.

1914.

Field.	Wells completed.				Initial daily production (barrels).	
	Oil.	Gas.	Dry.	Total.	Total.	Average per well.
Appalachian:						
Pennsylvania and New York	2,247	284	338	2,869	6,627	3.0
Southeastern and central Ohio	863	664	517	2,044	12,047	14.0
West Virginia	1,043	368	347	1,758	24,474	23.5
Kentucky	119	4	55	178	1,568	13.2
	4,272	1,320	1,257	6,849	44,716	10.5

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Wells drilled in the United States in 1914 and 1915—Continued.

1914—Continued.

Field.	Wells completed.				Initial daily production (barrels).	
	Oil.	Gas.	Dry.	Total.	Total.	Average per well.
Lima, Ohio	765	16	69	850	9,329	12.2
Indiana	470	13	259	742	8,436	18.0
	1,235	29	328	1,592	17,765	14.4
Illinois	1,191	32	356	1,579	39,268	33.0
Mid-Continent:						
Kansas	1,753	317	270	2,340	18,932	10.8
Oklahoma	6,410	539	1,343	8,292	976,244	152.3
Northern Texas	497	26	221	744	25,003	50.3
Northern Louisiana	302	52	91	445	102,193	338.4
	8,962	934	1,925	11,821	1,122,372	125.2
Gulf:						
Coastal Texas	323	11	130	464	160,695	497.5
Coastal Louisiana	72	1	48	121	82,914	1,151.6
	395	12	178	585	243,609	616.7
Alaska	1	.....	.....	1	.....	.....
California	512	.....	47	559	.....	.....
Colorado	12	.....	10	22	.....	.....
Wyoming and Utah	86	.....	29	115	.....	.....
Michigan	2	.....	.....	2	.....	.....
Miscellaneous	.....	.....	12	12	.....	.....
	16,668	2,327	4,142	23,137	.....	.....

1915.

Appalachian:						
Pennsylvania and New York	1,409	213	284	1,906	9,320	6.6
Southeastern and central Ohio	677	761	472	1,910	8,373	12.4
West Virginia	763	280	246	1,289	13,501	17.7
Kentucky	56	.....	36	92	728	13.0
Tennessee	4	1	7	12	250	62.5
	2,909	1,255	1,045	5,209	32,172	11.1
Lima, Ohio	224	10	27	261	4,496	20.1
Indiana	98	8	86	192	2,564	26.2
	322	18	113	453	7,060	21.9
Illinois	539	19	199	757	14,165	26.3
Mid-Continent:						
Kansas	610	331	147	1,088	11,319	18.6
Oklahoma	3,397	342	885	4,624	1,086,170	305.0
Northern Texas	195	22	91	308	9,493	48.7
Northern Louisiana	349	26	89	464	198,116	567.7
	4,551	721	1,212	6,484	1,255,098	275.8
Gulf:						
Coastal Texas	418	6	337	761	335,711	803.1
Coastal Louisiana	73	2	26	101	45,185	619.0
	491	8	363	862	380,896	775.8
Arkansas	.....	1	1	2	.....	.....
California	272	.....	20	292	.....	.....
Colorado	3	.....	6	9	.....	.....
Michigan	2	.....	.....	2	.....	.....
Missouri	2	.....	2	4	.....	.....
Wyoming and Utah	63	.....	11	74	.....	.....
Miscellaneous	.....	.....	9	9	.....	.....
	9,154	2,022	2,981	14,157	.....	.....

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FUEL OIL.

GENERAL STATEMENT.

The year 1915 was one of notable expansion in the domestic market for petroleum fuel. The continued overproduction of crude oil in Oklahoma supplementing, by the increased output of refinery residuums it provided, the surplus of fuel grades of petroleum supplied by the Gulf coast fields resulted in a confidence in the future supply and a current market price that greatly stimulated fuel-oil consumption. This was particularly notable in the Southwest, where railroads and industrial plants of all types, adjacent to the source of supply, adopted it to the exclusion of coal.

The hazards of ocean transportation between the United States and foreign ports served to increase the number of tankers available for service between this country and Mexico, with the result that imports of fuel oil from that country showed a decided increase in 1915. The adoption of Mexican fuel oil by certain of the railroads and large industrial consumers in the Southwest has influenced to some degree the more general adoption of liquid fuel by minor industries at some distance from tidewater, for it has forced the domestic producers to seek an inland market for their fuel grades of crude oil and their refinery residuals.

Along the Atlantic seaboard the use of petroleum for fuel is rapidly and steadily increasing, largely as a consequence of the energetic methods of strong marketing companies handling the semirefined Mexican oil in procuring a market for their product. In the New England section petroleum fuel has found an outlet of great possibilities, and the rapidity with which its use is increasing in the large textile and paper mills, in small industries, and even in domestic heating plants is ample evidence of the favor with which it is received. So great is this popularity that one of the largest marketing companies on the Atlantic seaboard is reported to have declined to make further contracts until its fleet of tank ships can be increased.

The use of petroleum on American merchant ships, especially in the Pacific, is almost general, and the popularity of this fuel in the Atlantic coastwise trade is rapidly making its use general there. In replacing merchant ships destroyed by submarines extensive use is being made of oil-burning equipment. Half the tonnage of the ocean cargo steamers now being built in America is said to consist of tankers, an indication of the line of future development of American trade. The American merchant fleet already includes, it is said, 102 tank steamers of 459,656 gross tons. Seventy-two tankers having a proposed tonnage of 496,138 tons are reported in process of building. Great Britain is credited with 208 steamers of this type, aggregating about 876,000 gross tons.

PRICES.

Prices for semirefined fuel oils at New England points and at New York varied little throughout the year, ranging between 90 cents and $1 a barrel according, largely, to the quantity purchased. Fuel distillates commanded a higher price as indicated in the following table compiled from the weekly quotations published in the Oil, Paint, and Drug Reporter (New York) for wholesale deliveries (barrels) at New York:

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Wholesale prices per gallon of fuel distillates at New York in 1915.

January 1	$0.080	September 13	$0.075
January 18	.070	October 4	.080
July 5	.080		

In other parts of the country prices ruled much lower, as shown in the following tabulation of average monthly prices per barrel for semirefined fuel oil at various marketing centers in the Southwest and West, compiled from the Fuel Oil Journal (Houston, Tex.):

Average monthly prices per barrel of semirefined fuel oil in 1915.

Month.	Houston, Tex.	Tulsa, Okla.	San Francisco, Cal.	Seattle, Wash.
January	$0.70	$0.40–$0.50	$0.65	$0.80
February	.70	.40– .50	.65	.80
March	$0.60– .65	.30– .40	.65	.80
April	.60– .65	.35– .40	.65	.80
May	.60– .65	.35– .40	.65	.80
June	.60– .65	.35– .40	.65	.80
July	.65– .73	.35– .40	.65	.80
August	.70– .75	.50– .55	.65	.80
September	.65– .70	.50– .55	.65	.80
October	.65– .70	.60– .65	.65	.80
November	.85	.75– .80		
December	.85	.90– 1.00	$0.80– .90	$1.00–1.10

CONSUMPTION.

Complete statistics of the consumption of fuel oil in the United States are not available. Data compiled from reports by pipe-line companies show that 48,860,000 barrels of domestic crude petroleum were delivered for fuel purposes in 1915. In addition more than 16,000,000 barrels of crude oil, much of which was used as fuel, was imported from Mexico; and indeterminate quantities of refinery products of domestic oil found the same use. In the oil fields of the United States no less than 3,191,000 barrels of crude oil, of which the transportation companies never secured a record, were consumed directly in drilling and pumping, the California fields requiring 2,602,000 barrels, or 82 per cent, of this total.

RAILROADS.

As anticipated in the chapter on petroleum in 1914, favorable prices for fuel oil in the later part of 1914 and the early part of 1915 resulted in a decided increase in consumption by the railroads.

In the South and Southwest proximity to the source of supply has been an important factor. In the Northwest, however, the convenience of fuel oil and its merits in reducing the number of forest fires ascribed to locomotives have been its chief recommendations.

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Fuel oil consumed by the railroads of the United States, 1906–1915.

Year.	Fuel oil consumed.	Length of line operated by the use of fuel oil.[a]	Total mileage made by oil-burning engines.	Average number of miles per barrel of oil consumed.
	Barrels.	*Miles.*	*Miles.*	*Miles.*
1906	15,577,677			
1907	18,849,803	13,573	74,079,726	3.93
1908	16,370,882	15,474	64,279,509	3.81
1909	19,905,335	17,676	72,918,118	3.66
1910	23,817,346	22,709	89,107,883	3.74
1911	29,743,845	30,089	109,680,976	3.69
1912	33,605,598	28,451	121,393,228	3.61
1913	33,004,815	29,145	118,672,162	3.60
1914	31,093,266	29,595	118,737,469	3.82
1915	36,648,466	30,776	124,255,525	3.39

[a] Some of these lines also used coal.

The following railroad companies used fuel oil on their lines in 1915:

Arizona:
- Atchison, Topeka & Santa Fe Railway System.
- Southern Pacific Co.

Arkansas:
- Kansas City Southern Railway Co.

California:
- Atchison, Topeka & Santa Fe Railway System.
- Northwestern Pacific Railroad Co.
- San Diego & Arizona Railway Co.
- San Diego & South Eastern Railway Co.
- San Pedro, Los Angeles & Salt Lake Railroad Co.
- Southern Pacific Co.
- Tonopah & Tidewater Railroad Co.
- Western Pacific Railway Co.

Florida:
- Florida East Coast Railway Co.

Georgia:
- Central of Georgia Railway Co. (on Tybee district).

Idaho:
- Chicago, Milwaukee & St. Paul Railway Co.
- Great Northern Railway Co.
- Idaho & Washington Northern Railroad.
- Oregon Short Line Railroad Co.
- Washington, Idaho & Montana Railway Co.

Kansas:
- Atchison, Topeka & Santa Fe Railway System.
- Kansas City Southern Railway Co.

Louisiana:
- Atchison, Topeka & Santa Fe Railway System.
- Kansas City Southern Railway Co.
- Louisiana Railway & Navigation Co.
- Louisiana Western Railroad Co.
- Morgan's Louisiana & Texas Railroad & Steamship Co.
- New Orleans, Texas & Mexico Railroad.
- Texas & Pacific Railway Co.

Missouri:
- Kansas City Southern Railway Co.

Montana:
- Chicago, Burlington & Quincy Railroad Co.
- Chicago, Milwaukee & St. Paul Railway Co. (west of Deer Lodge to the Idaho State line).
- Great Northern Railway Co.
- Oregon Short Line Railroad Co.

Nebraska:
- Chicago & North Western Railway Co.

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Nevada:
Atchison, Topeka & Santa Fe Railway System.
Bullfrog Goldfield Railroad Co.
Las Vegas & Tonopah Railroad Co.
San Pedro, Los Angeles & Salt Lake Railroad Co.
Southern Pacific Co.
Tonopah & Goldfield Railroad Co.
Tonopah & Tidewater Railroad Co.
Western Pacific Railway.
New Mexico:
Atchison, Topeka & Santa Fe Railway System.
El Paso Southwestern System.
Southern Pacific Co.
New York:
Delaware & Hudson Co. (in the Adirondacks).
Long Island Railroad Co.
New York Central Railroad Co. (in the Adirondacks, including Old Forge and the Fulton Chain).
Oklahoma:
Atchison, Topeka & Santa Fe Railway System.
Kansas City Southern Railway Co.
Oregon:
Corvallis & Eastern Railroad Co.
Great Northern Railway Co.
Northern Pacific Railway Co.
Oregon Trunk Railway Co.
Oregon-Washington Railroad & Navigation Co.
Pacific Railway & Navigation Co.
Southern Pacific Co.
Spokane, Portland & Seattle Railway Co.
South Dakota:
Chicago, Burlington & Quincy Railroad Co.
Chicago & North Western Railway Co.
Texas:
Atchison, Topeka & Santa Fe Railway System.
Forth Worth & Denver City Railway Co.
Galveston, Harrisburg & San Antonio Railway Co.
Galveston, Houston & Henderson Railroad Co.
Houston, East & West Texas Railway Co.
Houston & Shreveport Railroad Co.
Houston & Texas Central Railroad Co.
International & Great Northern Railway Co.
New Orleans, Texas & Mexico Railroad Co.
St. Louis, Brownsville & Mexico Railway.
San Antonio & Aransas Pass Railway Co.
Texarkana & Fort Smith Railway Co.
Texas & New Orleans Railroad Co.
Texas & Pacific Railway Co.
Trinity & Brazos Valley Railway Co.
Utah:
San Pedro, Los Angeles & Salt Lake Railroad Co.
Southern Pacific Co.
Washington:
Bellingham & Northern Railway Co.
Chicago, Milwaukee & St. Paul Railway Co.
Great Northern Railway Co.
Idaho & Washington Northern Railroad.
Northern Pacific Railway Co.
Oregon Trunk Railway Co.
Oregon-Washington Railroad & Navigation Co.
Spokane, Portland & Seattle Railway Co.
Washington, Idaho & Montana Railway Co.
Wyoming:
Chicago, Burlington & Quincy Railway Co.
Chicago & North Western Railway Co.
Wyoming & Northwestern Railway.

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UNITED STATES NAVY.

The consumption of fuel oil by the United States Navy during the fiscal year ending June 30, 1916, was approximately 47,000,000 gallons.

The following vessels of the Navy are equipped for oil burning: Eight battleships, fitted to burn coal or fuel oil; 3 battleships, fitted to burn fuel oil exclusively; 43 destroyers, fitted to burn fuel oil exclusively.

In addition, all battleships and torpedo vessels now building and authorized are designed to use fuel oil exclusively, and it is estimated that the requirements for fuel oil during the fiscal year 1916–17 will amount to at least 55,000,000 gallons.

The specifications under which fuel oil is supplied for the fiscal year 1916–17 are as follows:

(*a*) Fuel oil shall be a hydrocarbon oil of best quality, free from grit, acid, fibrous, or other foreign matter likely to clog or injure the burners or valves, and shall, if required by the Navy Department, be strained by being drawn through filters of wire gauze having 16 meshes to the inch. The clearance through the strainer shall be at least twice the area of the suction pipe and strainers shall be in duplicate.

(*b*) The unit of quantity to be the barrel of 42 gallons of 231 cubic inches at a standard temperature of 60° F. For every decrease or increase of temperature of 10° F. (or proportion thereof) from the standard, 0.4 of 1 per cent (or prorated percentage) shall be added or deducted from the measured or gaged quantity for correction.

(*c*) Flash point never under 150° F. as a minimum (Abel or Pennsky-Marten's closed cup), or 175° F. (Tagliabue open cup), and not lower than the temperature at which the oil has a viscosity of 8 Engler (water=1 Engler). (Example: If an oil has a viscosity of 8 Engler when heated to 186° F., then 186° F. is the minimum flash point at which this oil will be accepted.)

(*d*) Viscosity at 700° F. not greater than 200 Engler.

(*e*) Water and sediment not over 1 per cent. If in excess of 1 per cent, the excess to be subtracted from the volume, or the oil may be rejected.

NOTE.—If an Engler viscosimeter is not available, the Saybolt standard universal viscosimeter may be used, and 300 seconds Saybolt will be considered equivalent to 8 Engler, and 7,500 seconds Saybolt will be considered equivalent to 200 Engler.

The specification under (*c*) above is so drawn because it is considered inadvisable to heat oil above its flash point when burning it with mechanical atomization where the pressures run up to almost 300 pounds per square inch, and because it has been determined, by numerous experiments at the naval fuel-oil testing plant, that any clean oil may be efficiently burned if it is heated sufficiently to reduce its viscosity to 8 Engler.

Storage tanks of the capacity indicated are in service, building, or authorized at the following Atlantic and Pacific ports:

Storage tanks for fuel oil for United States Navy.

Port.	In service.	Under construction or authorized.	Port.	In service.	Under construction or authorized.
	Barrels.	*Barrels.*		*Barrels.*	*Barrels.*
Boston, Mass.	50,000	.....	Guantanamo, Cuba	214,000	143,000
Melville, R. I.	84,000	120,000	Pearl Harbor, Hawaii	236,000	142,000
Norfolk, Va.	34,000	250,000	San Diego, Cal.	.....	50,000
Charleston, S. C.	34,000	.....	Mare Island, Cal.	.....	250,000
Key West, Fla.	34,000	.....	Puget Sound, Wash.	.....	250,000

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The adoption by the Navy of the policy of storing its fuel supply in underground concrete-lined reservoirs instead of steel tanks aboveground constitutes an important development in naval fuel matters that is recommended by economic as well as strategic considerations.

In order to assure the Navy an adequate supply of petroleum fuel the President of the United States approved on April 30, 1915, an order creating naval petroleum reserve No. 3, involving 9,481 acres in Natrona County, Wyo. This area, which formed a part of petroleum reserve No. 8, created by Executive order of June 2, 1910, includes the Teapot dome, southeast of the Salt Creek field, 30 miles north of Casper.

As an added precaution to provide for future needs of the Navy a clause has been inserted in leases on all oil lands in the Osage Reservation in Oklahoma giving the Federal Government the right to purchase at prevailing market prices any oil it may require from these lands.

PETROLEUM OPERATORS' STATISTICS.

The statistics presented in this section are those obtained directly from the oil producers themselves. The object of this investigation, in addition to securing a check on the determination of marketed production, as reported by the pipe line and other oil-transporting companies, is to secure a record of petroleum utilized in field operations and to obtain details available in no other way concerning field storage, drilling activity, and acreage held for development.

Discrepancies between the output here recorded and that stated elsewhere in this report are due chiefly to the failure of all producing companies in a given State to furnish the information requested. In cases where the petroleum output of a State, as determined from this source, exceeds the accepted total used in other parts of the report, the discrepancy is accounted for by the fact that producers very naturally report as marketed production varying quantities of oil sold but not removed from tanks adjacent to the source of production during the year in review and consequently not accounted for by transportation agencies.

On the whole, however, the two sets of figures agree as closely as might be expected when all the varying factors involved are taken into consideration.

It will be noted that the statistics of wells completed as given in this section differ with respect to many States and counties from those given elsewhere in this chapter. The statistics presented here are those obtained from voluntary reports by the petroleum operators themselves and relate merely to the number of wells involved. Those published elsewhere, with the exception of the field reports for Colorado, Wyoming, Utah, California, Michigan, Alaska, and miscellaneous, which are obtained from the statements of the operators, are compiled from various trade journals, principally the Oil City Derrick and the Oil and Gas Journal, and are published because they are consistent since the beginning of the oil industry in the United States and because they furnish in addition to the number of wells completed an approximation of the output of each oil well the first day of its productive life. No attempt is made to procure data on this subject from the oil producers.

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Petroleum marketed, well record, and acreage held by operators in the United States in 1915.

[From statistics furnished by producers.]

State.	Production (barrels).			Value.	Average price per barrel.	Wells.					Average daily production per well (barrels).	Acreage.		
	Placed to credit of—		Total.			Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.		Fee.	Lease.	Total.
	Producer.	Landowner.					Oil.	Dry.						
Alaska			(a)	(a)		8				8		148	9,000	9,148
Arkansas								1				889	373,500	374,389
California	81,360,908	5,230,627	86,591,535	$36,558,439	$0.422	7,132	272	20	90	7,314	32.4	304,840	150,542	455,382
Colorado	208,267	208	208,475	183,485	.880	95	3	6	5	93	6.1	17,701	19,092	36,793
Illinois	15,594,529	2,887,940	18,482,469	18,524,335	1.002	14,800	517	126	137	15,180	3.3	3,134	251,083	254,217
Indiana	754,233	121,843	876,076	882,520	1.007	3,418	93	53	775	2,736	.9	6,611	106,981	113,592
Kansas	1,964,834	256,530	2,221,364	1,329,575	.599	3,460	469	158	256	3,673	1.7	36,388	401,192	437,580
Kentucky	368,972	45,688	414,660	414,027	.998	1,032	76	51	49	1,059	1.1	22,024	112,521	134,545
Louisiana	13,930,187	2,194,967	16,125,154	9,918,237	.615	1,177	499	130	142	1,534	28.8	26,338	616,441	642,779
Michigan			(a)	(a)		26	2			28		15	13,000	13,015
Missouri			(a)	(a)		12	2	2		14			27,052	27,052
Montana								2						
New Mexico			(b)			1		2		1		180	69,522	69,702
New York	752,002	57,729	809,731	1,303,859	1.610	11,125	101	7	160	11,066	.2	36,338	68,206	104,544
Ohio	5,565,140	864,259	6,429,399	8,685,509	1.351	31,864	768	276	1,848	30,784	.6	66,790	738,114	804,904
Oklahoma	90,429,921	13,897,898	104,327,819	61,793,716	.592	27,803	2,193	339	865	29,131	9.8	75,508	1,887,257	1,962,765
Pennsylvania	6,021,040	632,027	6,653,067	10,814,843	1.626	58,254	1,368	182	1,179	58,443	.3	282,585	806,019	1,088,604
Tennessee		(b)					4	11		4			47,700	47,700
Texas	19,610,772	2,471,795	22,082,567	13,211,439	.598	3,841	726	483	236	4,331	14.0	48,093	802,929	851,022
Utah		(b)				5	1			6		16,257		16,257
Washington		(b)				1		5	1			300	10,600	10,900
West Virginia	7,322,326	1,043,247	8,365,573	13,628,084	1.629	15,069	711	111	443	15,337	1.5	30,373	2,422,987	2,453,360
Wyoming	4,145,431	100,094	4,245,525	2,217,018	.522	265	62	11	7	320	36.3	13,164	80,331	93,495
Other States c	14,095	170	14,265	24,295	1.704						.8			
Total, 1914	248,042,657	29,805,022	277,847,679	179,489,381	.646	179,388	7,867	1,975	6,193	181,062	4.2	987,676	9,014,069	10,001,745
	243,227,101	26,743,088	269,970,189	210,189,095	.779	169,440	15,371	2,915	5,428	179,383	4.1	1,445,142	8,342,733	9,787,875

a Included in "Other States." b No production. c Includes Alaska, Michigan, and Missouri.

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Wells drilled and acreage held in 1915 in oil-producing States.

New York.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Allegany	7,714	53	4	101	7,666	22,447	37,421	59,868
Cattaraugus	3,209	27	3	59	3,177	13,891	29,744	43,635
Steuben	202	21	.....	.....	223	.....	1,041	1,041
Total, 1914	11,125	101	7	160	11,066	36,338	68,206	104,544
	10,681	638	9	194	11,125	39,062	78,039	117,101

Pennsylvania.

Allegheny	1,729	76	27	49	1,756	3,667	63,433	67,100
Armstrong	185	3	2	4	184	1,943	2,164	4,107
Beaver	663	13	8	11	665	1,480	16,171	17,651
Butler	5,605	108	28	93	5,620	32,718	88,149	120,867
Clarion	1,904	97	25	36	1,965	16,523	45,581	62,104
Crawford	680	27	3	3	704	1,031	4,301	5,332
Elk	1,140	11	.....	3	1,148	11,757	59,625	71,382
Forest	1,692	14	25	97	1,609	29,409	38,451	67,860
Greene	515	5	3	10	510	1,766	103,371	105,137
Jefferson	153	1	3	4	150	522	39,994	40,516
Lawrence	1,063	26	2	87	1,002	239	14,669	14,908
McKean	15,376	393	7	165	15,604	73,579	115,830	189,409
Mercer	278	48	.....	.....	326	258	2,729	2,987
Potter	92	.....	.....	.....	92	1,522	688	2,210
Tioga	24	.....	.....	.....	24	.....	367	367
Venango	18,104	307	32	516	17,895	65,342	71,917	137,259
Warren	7,233	172	13	66	7,339	36,733	53,054	89,787
Washington	1,818	67	4	35	1,850	4,096	85,525	89,621
Total, 1914	58,254	1,368	182	1,179	58,443	282,585	806,019	1,088,604
	55,294	a 3,569	265	609	58,254	306,229	695,245	1,001,474

West Virginia.

Boone	.....	.....	2	.....	.....	.....	55,021	55,021
Braxton	4	11	1	.....	15	.....	1,861	1,861
Brooke	271	15	2	4	282	1,539	3,757	5,296
Cabell	23	2	1	.....	25	125	11,419	11,544
Calhoun	286	2	.....	23	265	501	33,426	33,927
Clay	47	16	.....	.....	63	.....	46,496	46,496
Doddridge	579	35	4	27	587	1,716	108,397	110,113
Gilmer	94	11	2	4	101	.....	63,003	63,003
Hancock	352	6	7	11	347	2,026	4,676	6,702
Harrison	1,331	40	6	33	1,338	3,571	125,442	129,013
Jackson	1	.....	1	.....	1	.....	66,950	66,950
Kanawha	685	90	3	60	715	3,948	451,414	455,362
Lewis	277	4	.....	5	276	.....	126,601	126,601
Lincoln	683	88	7	2	769	259	490,485	490,744
Logan	.....	.....	1	.....	.....	.....	1,770	1,770
Marion	706	30	1	24	712	128	61,719	61,847
Marshall	140	.....	2	11	129	9	18,839	18,848
Mason	3	.....	.....	.....	3	.....	1,113	1,113
Monongalia	709	17	2	7	719	641	46,095	46,736
Nicholas	.....	.....	1	.....	.....	.....	675	675
Ohio	4	.....	.....	.....	4	.....	5	5
Pleasants	1,685	65	14	43	1,707	1,464	29,599	31,063
Putnam	2	.....	.....	1	1	.....	32,574	32,574
Ritchie	1,965	53	20	78	1,940	4,110	58,956	63,066
Roane	1,141	52	4	18	1,175	3,836	328,375	332,211
Tyler	1,488	70	6	16	1,542	533	70,672	71,205
Wayne	4	4	.....	1	7	.....	39,240	39,240
Wetzel	1,149	31	3	36	1,144	407	104,416	104,823
Wirt	509	44	13	33	520	3,289	15,957	19,246
Wood	931	25	8	6	950	2,271	24,034	26,305
Total, 1914	15,069	711	111	443	15,337	30,373	2,422,987	2,453,360
	14,544	1,130	218	605	15,069	98,863	2,508,663	2,607,526

a Includes many wells previously abandoned but cleaned out and made productive during 1914.

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Wells drilled and acreage held in 1915 in oil-producing States—Continued.

Kentucky.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Allen	28	6	3	3	31	10	10,822	10,835
Barren	7	.....	.....	.....	7	31	514	542
Bath	90	.....	.....	1	89	.....	800	800
Daviess	.....	.....	6	.....	.....	.....	.....	.....
Edmonson	.....	1	.....	.....	1	.....	5,000	5,000
Estill	4	4	.....	.....	8	5,000	5,020	10,020
Floyd	20	.....	.....	.....	20	.....	2,675	2,675
Knott	2	.....	.....	.....	2	.....	578	578
Lawrence	35	14	3	6	43	933	9,257	10,190
Lewis	6	.....	.....	.....	6	.....	12,000	12,000
Logan	6	.....	.....	.....	6	.....	578	578
McCreary	.....	6	4	.....	6	7,000	220	7,220
Morgan	37	1	1	11	27	1,200	5,560	6,760
Ohio	6	.....	.....	2	4	.....	1,500	1,500
Rowan	35	.....	2	.....	35	2,500	2,500	5,000
Wayne	617	37	28	26	628	5,350	48,397	53,747
Wolfe	139	7	4	.....	146	.....	7,100	7,100
Total, 1914	1,032	76	51	49	1,059	22,024	112,521	134,545
	968	125	41	61	1,032	8,778	200,302	209,080

Ohio.

Allen	1,453	1	.....	549	905	719	25,620	26,339
Ashland	6	.....	.....	.....	6	.....	515	515
Athens	127	28	4	2	153	793	9,692	10,485
Auglaize	517	5	.....	36	486	1,255	18,317	19,572
Belmont	186	5	.....	2	189	550	35,167	35,717
Carroll	56	21	25	4	73	.....	38,388	38,388
Columbiana	394	13	16	23	384	404	13,276	13,680
Coshocton	68	3	1	9	62	6	26,563	26,569
Cuyahoga	2	3	19	2	3	60	32,707	32,767
Fairfield	303	9	3	17	295	.....	10,682	10,682
Guernsey	8	1	.....	.....	9	.....	690	690
Hancock	3,283	42	1	171	3,154	2,447	31,029	33,476
Hardin	3	.....	.....	.....	3	413	400	813
Harrison	718	6	1	41	683	4,449	10,933	15,382
Hocking	211	61	7	7	265	3,024	47,450	50,474
Holmes	37	.....	.....	.....	37	.....	2,407	2,407
Jackson	1	.....	.....	1	.....	.....	120	120
Jefferson	518	17	17	14	521	1,912	22,970	24,882
Knox	10	1	1	1	10	175	1,425	1,600
Lake	1	.....	.....	1	.....	.....	.....	.....
Lawrence	18	.....	1	2	16	.....	407	407
Licking	68	7	2	2	73	200	22,864	23,064
Logan	6	.....	3	3	3	1,000	1,000	2,000
Lorain	8	.....	2	.....	8	.....	7,700	7,700
Lucas	495	7	2	7	495	848	5,303	6,151
Mahoning	139	1	2	7	133	78	2,569	2,647
Medina	2	.....	.....	.....	2	.....	240	240
Meigs	9	.....	.....	2	7	110	1,010	1,120
Mercer	675	2	.....	89	588	1,052	14,652	15,704
Monroe	2,603	30	10	80	2,553	4,757	53,948	58,705
Morgan	1,055	90	35	14	1,131	3,030	11,290	14,320
Muskingum	190	7	1	20	177	246	28,066	28,312
Noble	532	56	13	19	569	2,417	9,392	11,809
Ottawa	445	7	1	31	421	1,993	6,201	8,194
Perry	669	18	8	35	652	3,192	44,158	47,350
Sandusky	4,148	29	4	125	4,052	6,075	36,851	42,926
Seneca	637	17	.....	17	637	1,084	5,179	6,263
Shelby	17	.....	.....	1	16	.....	400	400
Trumbull	20	.....	.....	.....	20	502	1,260	1,762
Van Wert	647	5	1	77	575	1,044	10,281	11,325
Vinton	8	3	8	1	10	60	22,067	22,127
Washington	4,112	153	82	253	4,012	10,687	53,923	64,610
Wayne	40	.....	.....	.....	40	.....	1,266	1,266
Wood	7,352	120	6	116	7,356	11,314	67,436	78,750
Wyandot	67	.....	.....	67	.....	894	2,300	3,194
Total, 1914	31,864	768	276	1,848	30,784	66,790	738,114	804,904
	31,208	1,832	292	1,176	31,864	56,698	948,947	1,005,640

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Wells drilled and acreage held in 1915 in oil-producing States—Continued.

Indiana.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Adams	453	.....	.....	83	370	1,135	6,780	7,915
Blackford	133	.....	.....	69	64	200	4,580	4,780
Clay	.....	.....	1	.....	.....	.....	.....	.....
Daviess	3	.....	1	.....	3	140	7,120	7,260
Delaware	143	.....	1	29	114	300	5,584	5,884
Gibson	120	1	1	5	116	140	4,420	4,560
Grant	248	.....	.....	100	148	200	8,851	9,051
Greene	6	.....	1	.....	6	.....	1,500	1,500
Hamilton	1	.....	.....	1	.....	.....	.....	.....
Harrison	3	.....	.....	3	.....	.....	.....	.....
Huntington	248	.....	.....	64	184	210	4,540	4,750
Jay	750	1	.....	111	649	3,163	9,571	12,734
Orange	.....	.....	1	.....	.....	.....	15,000	15,000
Pike	160	2	6	6	156	40	1,730	1,770
Randolph	51	6	.....	15	42	200	8,980	9,180
Sullivan	434	70	34	1	503	.....	16,673	16,673
Vigo	9	13	7	.....	22	.....	1,682	1,682
Wells	647	.....	.....	288	359	883	9,970	10,853
Total, 1914	3,418	93	53	775	2,736	6,611	106,981	113,592
	3,814	434	119	830	3,418	11,139	88,842	99,981

Illinois.

Clark	2,259	21	5	22	2,258	650	25,581	26,231
Clinton	150	.....	1	.....	150	.....	36,000	36,000
Coles	84	.....	.....	2	82	156	690	846
Crawford	7,480	169	50	40	7,609	190	72,321	72,511
Cumberland	683	75	8	.....	758	111	7,452	7,563
Edgar	9	2	.....	.....	11	955	.....	955
Hancock	1	.....	2	.....	1	.....	1,600	1,600
Jasper	8	1	.....	.....	9	.....	620	620
Lawrence	3,848	150	21	65	3,933	369	59,201	59,570
McDonough	144	95	25	2	237	203	12,006	12,209
Macoupin	9	.....	2	4	5	.....	3,320	3,320
Madison	2	.....	.....	.....	2	340	8,000	8,340
Marion	100	4	.....	2	102	.....	19,532	19,532
Montgomery	.....	.....	1	.....	.....	.....	.....	.....
Morgan	3	.....	.....	.....	3	160	400	560
Schuyler	.....	.....	9	.....	.....	.....	1,600	1,600
St. Clair	.....	.....	2	.....	.....	.....	.....	.....
Wabash	20	.....	.....	.....	20	.....	2,760	2,760
Total, 1914	14,800	517	126	137	15,180	3,134	251,083	254,217
	14,100	953	227	253	14,800	3,479	293,095	296,574

Kansas.

Allen	365	50	32	28	387	2,941	16,773	19,714
Anderson	.....	.....	4	.....	.....	.....	.....	.....
Butler	1	19	4	.....	20	.....	104,060	104,060
Chautauqua	1,233	114	29	32	1,315	12,914	52,992	65,906
Clark	.....	.....	1	.....	.....	10,000	7,000	17,000
Coffey	19	4	.....	.....	23	.....	1,195	1,195
Cowley	1	1	6	.....	2	.....	20,354	20,354
Elk	6	1	2	.....	7	.....	160	160
Franklin	113	31	5	6	138	1,290	4,761	6,051
Labette	7	3	3	.....	10	60	4,200	4,260
Miami	116	38	13	9	145	351	9,384	9,735
Montgomery	1,034	145	38	131	1,048	6,974	144,616	151,590
Neosho	384	53	18	23	414	1,660	25,052	26,712
Wilson	177	10	3	25	162	198	10,603	10,801
Woodson	4	.....	.....	2	2	.....	42	42
Total, 1914	3,460	469	158	256	3,673	36,388	401,192	437,580
	3,054	600	156	194	3,460	21,450	262,186	283,636

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Wells drilled and acreage held in 1915 in oil-producing States—Continued.

Oklahoma.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Blaine			2				3,000	3,000
Bryan			1				2,330	2,330
Carter	437	195	11	16	616	2,275	29,606	31,881
Coal			2				13,412	13,412
Comanche	13	2	2	2	13	160	2,225	2,385
Craig	9	5	2	1	13	40	307	347
Creek	3,347	947	49	114	4,180	9,345	236,372	245,717
Garvin		8	1		8	5,000	15,298	20,298
Greer			1				160	160
Hughes		1			1		60,058	60,058
Jackson			1					
Jefferson	1	3	4		4		1,150	1,150
Johnston			3				1,280	1,280
Kay	128	17	11	8	137	1,555	70,146	71,701
Kiowa	14			8	6	160	640	800
Lincoln			3			11,983	29,357	41,340
Love		1			1		2,900	2,900
McCurtain			1					
McIntosh	4	6	2		10		14,769	14,769
Marshall	4		4	1	3	20	2,290	2,310
Muskogee	361	74	34	10	425	947	39,259	40,206
Nowata	6,935	189	33	141	6,983	4,890	75,773	80,663
Okfuskee	12	6	3		18		56,062	56,062
Oklahoma	1		1		1		840	840
Okmulgee	1,258	221	45	54	1,425	13,375	116,336	129,711
Osage	2,692	115	18	175	2,632	885	544,740	545,625
Ottawa			1				500	500
Pawnee	690	27	3	94	623	268	49,598	49,866
Payne	12	7	2	9	10	182	10,070	10,252
Pontotoc	6	1	2	1	6	70	23,572	23,642
Pottawatomie			1			1,500	26,929	28,429
Rogers	2,341	38	10	112	2,267	2,165	33,321	35,486
Seminole	2			2			43,893	43,893
Stephens	1	1	1		2		15,990	15,990
Tulsa	3,392	174	48	53	3,513	10,895	201,384	212,279
Wagoner	33	15	10	2	46	346	5,412	5,758
Washington	6,110	140	27	62	6,188	9,447	158,278	167,725
Total, 1914	27,803 24,085	2,193 4,501	339 1,071	865 783	29,131 27,803	75,508 222,599	1,887,257 1,825,874	1,962,765 2,048,473

Texas.

Archer	4	6	2		10	236	5,800	6,036
Bastrop		1	16	1			1,444	1,444
Bell			3				10,640	10,640
Bexar	3	9			12		1,097	1,097
Brewster	2			2				
Brown	5			5			1,888	1,888
Burleson			1					
Caldwell			2			1,200	3,149	4,349
Cameron			1				5,000	5,000
Chambers			2				1,547	1,547
Cherokee		1		1			11,000	11,000
Clay	323	35	6	10	348	6,225	12,881	19,106
Coleman	1		1		1	2,200	18,118	20,318
Cooke			1					
Dallas			1					
Duval	1	6	2		7	36	3,200	3,236
Eastland			2			500	6,500	7,000
Falls			2					
Fayette			5			2,385	5,955	8,340
Fort Bend			2				200	200
Galveston			2					
Grayson			1			160	1,000	1,160
Hardin	1,004	151	61	88	1,067	3,860	5,067	8,927
Harris	360	151	54	65	446	5,324	12,015	17,339
Haskell			1					
Hill			2			78	2,500	2,578
Jack	48	6	6	2	52		29,000	29,000

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Wells drilled and acreage held in 1915 in oil-producing States—Continued.

Texas—Continued.

County.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Jefferson	93	19	6	11	101	30	1,251	1,281
Karnes			1					
Kaufman			6				200	200
Kleberg			1					
Knox			2				3,600	3,600
Lee			3				196	196
Leon			1				708	708
Liberty	4		9		4	2,515	2,477	4,992
Limestone			1					
McLennan	12				12	320		320
McMullen	22	1			23		4,326	4,326
Madison			3				3,935	3,935
Marion	34	5	2		39	3,802	8,293	12,095
Matagorda	33	7	2	9	31	657	3,449	4,106
Milam		1	29	1		4,370	11,242	15,612
Montgomery			1				200	200
Nacogdoches	2				2		1,431	1,431
Navarro	856	12	9	4	864	141	17,277	17,418
Nueces			2			25	10,100	10,125
Orange	1		4		1	1	871	872
Palo Pinto		45	45	1	44	10,000	110,640	120,640
Polk			1					
Red River			1					
Robertson			1					
San Patricio			1			50	3,052	3,102
Shackelford	6	13	3	14	5	3	72,377	72,380
Stephens			1					
Throckmorton			1					
Travis			1				4,300	4,300
Trinity			2				3,000	3,000
Walker			1				3,700	3,700
Washington		1	7		1		3,925	3,925
Wharton			3					
Wichita	1,025	127	25	18	1,134	2,854	322,846	325,700
Wilbarger	2		1		2	240	36,388	36,628
Williamson		129	125	4	125	546	27,300	27,846
Wilson			2			335	844	1,179
Wood			4				7,000	7,000
Total, 1914	3,841	726	483	236	4,331	48,093	802,929	851,022
	3,542	646	310	347	3,841	226,478	586,468	812,946

Louisiana.

Acadia	70	12	1	6	76	782	1,906	2,688
Bossier			3			591	10,880	11,471
Caddo	914	118	33	79	953	18,790	174,884	193,674
Calcasieu	91	55	26	34	112	806	5,423	6,229
Catahoula			1					
De Soto	78	83	27	21	140	754	96,461	97,215
Grant			2			160	75,000	75,160
Jefferson Davis	6	5	4	1	10	163	2,173	2,336
Natchitoches			1				8,496	8,496
Red River	10	224	22		234	256	202,339	202,595
Sabine	2		5	1	1	316	38,693	39,009
St. Martin	6	2	2		8	3,200	86	3,286
Tensas			1					
Vermilion			1					
Webster			1			520	100	620
Total, 1914	1,177	499	130	142	1,534	26,338	616,441	642,779
	986	328	110	137	1,177	18,726	491,416	510,142

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PIPE-LINE STATISTICS.

Under this heading are included statistics furnished by pipe-line and other transporting agencies, with which are incorporated, wherever appropriate and without differentiation, supplemental data, including statistics of fuel consumed in field operations and statistics of local sales of crude petroleum by producers, concerning which the transportation companies would have no record.

APPALACHIAN OIL FIELD.

GENERAL STATEMENT.

The Appalachian field embraces all oil pools east of central Ohio and north of central Alabama, including those of New York, Pennsylvania, West Virginia, southeastern Ohio, Kentucky, Tennessee, and northern Alabama.

The formations that yield oil in this field include those of the Devonian and Carboniferous systems. The oil occurs generally along the axes and flanks of anticlines, parallel in general with the strike of the Appalachian Mountains, on minor terraces or other structures associated with them, and rarely in waterless synclines. The reservoir rocks are mainly sandstone or conglomerate layers, the most notable exception being the Big lime (Greenbrier limestone), a calcareous stratum that yields oil in West Virginia.

MARKETED PRODUCTION.

Petroleum marketed in the Appalachian oil field in 1914 and 1915, in barrels.

1914.

Month.	Pennsylvania.	New York.	Southeastern Ohio.	West Virginia.	Kentucky.	Total.
January	677,284	78,983	444,426	855,886	46,930	2,103,509
February	532,826	62,424	363,537	770,300	44,545	1,773,632
March	726,605	80,660	464,675	919,377	53,860	2,245,177
April	782,378	88,268	448,909	900,998	50,465	2,271,018
May	701,685	84,548	436,266	864,519	44,903	2,131,921
June	724,172	84,110	428,753	872,074	44,361	2,153,470
July	731,080	84,783	456,139	897,065	42,630	2,211,697
August	646,412	75,512	195,617	272,098	26,758	1,216,397
September	688,761	76,102	299,372	675,518	21,177	1,760,930
October	704,024	81,569	507,031	985,724	51,625	2,329,973
November	614,126	71,593	373,117	799,728	36,900	1,895,464
December	640,982	70,422	391,423	866,746	38,287	2,007,860
	8,170,335	938,974	4,809,265	9,680,033	502,441	24,101,048

1915.

January	629,588	74,101	382,236	777,702	34,898	1,898,525
February	615,005	67,755	361,100	754,034	35,707	1,833,601
March	672,343	79,840	398,430	848,926	39,562	2,039,101
April	697,036	79,018	385,427	801,046	40,015	2,002,542
May	638,490	75,114	362,097	767,685	39,323	1,882,709
June	683,410	76,408	377,345	789,545	37,070	1,963,778
July	682,583	79,012	366,426	780,749	35,905	1,944,675
August	655,242	72,531	357,799	761,111	37,531	1,884,214
September	654,036	72,914	353,556	752,751	34,929	1,868,186
October	645,333	72,399	363,534	716,638	33,564	1,831,468
November	623,955	66,218	342,700	720,267	34,702	1,787,842
December	641,684	72,468	380,843	794,344	34,068	1,923,407
	7,838,705	887,778	4,431,493	9,264,798	437,274	22,860,048
Decrease, 1915:						
Barrels	331,630	51,196	377,772	415,235	65,167	1,241,000
Per cent	4.06	5.45	7.86	4.30	12.97	5.15

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Petroleum marketed in the Appalachian field since 1859.

Year.	Quantity (barrels).	Percentage of total production.	Increase or decrease.		Value.	Yearly average price per barrel.
			Barrels.	Per cent.		
1859	2,000	100.00			$32,000	$16.000
1860	500,000	100.00	+ 498,000	+24,900.00	4,800,000	9.590
1861	2,113,609	100.00	+1,613,609	+ 322.72	1,085,668	.490
1862	3,056,690	100.00	+ 943,081	+ 44.62	3,209,525	1.050
1863	2,611,309	100.00	− 445,381	− 14.57	8,225,663	3.150
1864	2,116,109	100.00	− 495,200	− 18.96	20,896,576	8.060
1865	2,497,700	100.00	+ 381,591	+ 18.03	16,459,853	6.590
1866	3,597,700	100.00	+1,100,000	+ 44.04	13,455,398	3.740
1867	3,347,300	100.00	− 250,400	− 6.96	8,066,993	2.410
1868	3,646,117	100.00	+ 298,817	+ 8.93	13,217,174	3.625
1869	4,215,000	100.00	+ 568,883	+ 15.60	23,730,450	5.638
1870	5,260,745	100.00	+1,045,745	+ 24.81	20,503,754	3.900
1871	5,205,234	100.00	− 55,511	− 1.06	22,591,180	4.340
1872	6,293,194	100.00	+1,087,960	+ 20.90	21,440,503	3.640
1873	9,893,786	100.00	+3,600,592	+ 57.21	18,100,464	1.830
1874	10,926,945	100.00	+1,033,159	+ 10.44	12,647,527	1.170
1875	8,787,514	100.00	−2,139,431	− 19.58	7,368,133	1.350
1876	9,120,669	99.87	+ 333,155	+ 3.79	22,952,822	2.563
1877	13,337,363	99.90	+4,216,694	+ 46.23	31,756,066	2.420
1878	15,381,641	99.90	+2,044,278	+ 15.33	18,009,346	1.190
1879	19,894,288	99.90	+4,512,647	+ 29.34	17,164,836	.859
1880	26,245,571	99.85	+6,351,283	+ 31.93	24,506,963	.945
1881	27,561,376	99.64	+1,315,805	+ 5.01	25,217,612	.915
1882	30,221,261	99.58	+2,659,885	+ 9.65	23,768,839	.786
1883	23,306,776	99.39	−6,914,485	− 22.88	25,460,252	1.092
1884	23,956,438	98.92	+ 649,662	+ 2.79	19,990,746	.834
1885	21,533,785	98.51	−2,422,653	− 10.11	18,447,493	.856
1886	26,549,827	94.60	+5,016,042	+ 23.29	18,681,910	.704
1887	22,878,241	80.90	−3,671,586	− 13.83	16,279,971	.712
1888	16,941,397	61.36	−5,936,844	− 25.95	14,836,701	.876
1889	22,355,225	63.57	+5,413,828	+ 31.96	24,485,407	.941
1890	30,066,560	65.61	+7,711,335	+ 34.50	30,121,968	.868
1891	35,848,777	66.03	+5,782,217	+ 19.23	24,219,863	.670
1892	33,432,377	66.19	−2,416,400	− 6.74	18,830,773	.556
1893	31,365,890	64.76	−2,066,487	− 6.18	20,327,232	.640
1894	30,783,424	62.38	− 582,466	− 1.86	26,030,125	.839
1895	30,960,639	58.54	+ 177,215	+ .58	42,206,898	1.359
1896	33,971,902	55.73	+3,011,263	+ 9.73	40,203,418	1.179
1897	35,230,271	58.25	+1,258,369	+ 3.70	27,877,213	.786
1898	31,717,425	57.29	−3,512,846	− 9.97	29,096,057	.911
1899	33,068,356	57.94	+1,350,931	+ 4.26	43,041,677	1.294
1900	36,295,433	57.05	+3,227,077	+ 9.76	49,295,298	1.353
1901	33,618,171	48.45	−2,677,262	− 7.38	40,796,328	1.210
1902	32,018,787	36.07	−1,599,384	− 4.76	40,451,593	1.238
1903	31,558,248	31.41	− 460,539	− 1.44	49,905,813	1.590
1904	31,408,567	26.83	− 149,681	− .47	50,598,184	1.628
1905	29,366,960	21.80	−2,041,607	− 6.50	40,279,635	1.394
1906	27,741,472	21.93	−1,625,488	− 5.54	43,633,601	1.598
1907	25,342,137	15.26	−2,399,335	− 8.65	43,766,686	1.745
1908	24,945,517	13.97	− 396 620	− 1.57	43,888,020	1.780
1909	26,535,844	14.49	+1,590,327	+ 6.38	43,237,233	1.646
1910	26,892,579	12.83	+ 356,735	+ 1.33	35,841,749	1.336
1911	23,749,832	10.77	−3,142,747	− 11.37	30,830,354	1.308
1912	26,338,516	11.81	+2,588,684	+ 10.90	42,818,384	1.626
1913	25,921,785	10.43	− 416,731	− 1.58	63,708,991	2.458
1914	24,101,048	9.07	−1,820,737	− 7.02	45,239,201	1.877
1915	22,860,048	8.13	−1,241,000	− 5.15	35,468,973	1.552
	1,148,495,375	31.76			1,518,995,582	1.323

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Petroleum marketed, value, and average price per barrel in the Appalachian field, 1906–1915.

Year.	Pennsylvania.			New York.			Southeastern Ohio.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1906..	10,256,893	$16,596,943	$1.618	1,243,517	$1,995,377	$1.605	4,906,579	$7,839,359	$1.597
1907..	9,999,306	17,579,706	1.758	1,212,300	2,127,748	1.755	4,214,391	7,344,408	1.742
1908..	9,424,325	16,881,194	1.791	1,160,128	2,071,533	1.786	4,110,121	7,316,617	1.780
1909..	9,299,403	15,424,554	1.658	1,134,897	1,878,217	1.655	4,717,436	7,773,880	1.648
1910..	8,794,662	11,908,914	1.354	1,053,838	1,414,668	1.342	4,822,234	6,469,939	1.342
1911..	8,248,158	10,894,074	1.321	952,515	1,248,950	1.311	4,281,237	5,591,423	1.306
1912..	7,837,948	12,886,752	1.644	874,128	1,401,890	1.604	5,013,110	8,177,189	1.631
1913..	7,917,302	19,690,502	2.487	948,191	2,284,307	2.409	4,964,425	12,229,610	2.463
1914..	8,170,335	15,573,822	1.906	938,974	1,760,868	1.875	4,809,265	8,937,415	1.858
1915..	7,838,705	12,431,353	1.584	887,778	1,390,325	1.566	4,431,493	6,760,660	1.526

Year.	West Virginia.			Kentucky-Tennessee.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1906..	10,120,935	$16,170,393	$1.005	1,213,548	$1,081,629	$0.850	27,741,472	$43,633,601	$1.573
1907..	9,095,296	15,852,428	1.743	820,344	862,396	1.051	25,342,137	43,766,686	1.729
1908..	9,523,176	16,911,865	1.776	[a] 727,767	706,811	.971	24,945,517	43,888,020	1.759
1909..	10,745,092	17,642,283	1.642	[a] 639,016	518,299	.811	26,535,844	43,237,233	1.629
1910..	11,753,071	15,723,544	1.338	[a] 468,774	324,684	.692	26,892,579	35,841,749	1.332
1911..	9,795,464	12,767,293	1.303	[a] 472,458	328,614	.695	23,749,832	30,830,354	1.298
1912..	12,128,962	19,927,721	1.643	[a] 484,268	424,842	.877	26,338,516	42,818,384	1.626
1913..	11,567,299	28,828,814	2.492	[a] 524,568	675,748	1.288	25,921,785	63,708,961	2.458
1914..	9,680,033	18,468,540	1.908	[a] 502,441	498,556	.992	24,101,048	45,239,201	1.877
1915..	9,264,798	14,468,278	1.561	[a] 437,274	418,357	.957	22,860,048	35,468,973	1.552

[a] No production in Tennessee recorded.

Petroleum marketed in the Appalachian oil field, 1911–1915, in barrels.

Month.	1911	1912	1913	1914	1915
January	1,974,600	1,694,048	2,178,053	2,103,509	1,898,525
February	1,884,336	1,834,665	1,982,615	1,773,632	1,833,601
March	2,097,333	2,227,769	2,046,832	2,245,177	2,039,101
April	1,974,035	2,276,208	2,307,646	2,271,018	2,002,542
May	2,162,836	2,462,881	2,251,441	2,131,921	1,882,709
June	2,031,071	2,360,533	2,188,442	2,153,470	1,963,778
July	1,914,966	2,413,806	2,253,474	2,211,697	1,944,675
August	2,033,142	2,442,319	2,130,941	1,216,397	1,884,214
September	1,907,771	2,133,327	2,135,811	1,760,930	1,868,186
October	1,964,172	2,253,291	2,237,913	2,329,973	1,831,468
November	1,834,182	2,033,801	1,972,899	1,895,464	1,787,842
December	1,971,408	2,205,868	2,235,718	2,007,860	1,923,407
	23,749,832	26,338,516	25,921,785	24,101,048	22,860,048

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Average daily output of petroleum in the Appalachian oil field, 1911–1915, in barrels.

Month.	1911	1912	1913	1914	1915
January	63,697	54,647	70,260	67,855	61,243
February	67,298	63,264	70,808	63,344	65,486
March	67,656	71,864	66,027	72,425	65,777
April	65,801	74,259	76,921	75,701	66,751
May	69,769	82,029	72,627	68,772	60,733
June	67,702	76,684	72,948	71,782	65,459
July	61,773	77,865	72,693	71,345	62,731
August	65,585	78,784	68,740	39,239	60,781
September	63,592	71,111	71,194	58,698	62,273
October	63,360	72,687	72,191	75,160	59,080
November	61,139	67,793	75,763	63,182	59,595
December	63,594	71,157	72,120	64,770	62,045
Average	65,068	71,963	71,024	66,030	62,630

RUNS, STOCKS, AND DELIVERIES.

RUNS.

Pipe-line runs of Appalachian oil in 1914 and 1915, in barrels.

1914.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	New York Transit.	Tidewater.
January	221,853	112,692	792,025	45,091	17,411	105,207
February	169,817	91,767	716,046	42,737	13,645	84,593
March	242,875	121,903	855,596	52,135	17,365	112,549
April	268,840	122,671	836,707	48,555	19,140	122,902
May	233,442	123,342	805,100	43,018	18,521	115,585
June	244,053	122,384	814,366	42,464	18,215	116,619
July	242,813	126,259	832,107	40,698	18,125	118,370
August	226,878	116,372	233,037	24,985	17,773	98,065
September	227,084	116,875	621,755	19,249	15,671	117,830
October	239,048	119,033	921,542	49,494	17,398	116,267
November	200,170	101,975	746,688	34,960	15,359	102,393
December	205,645	109,846	811,632	36,224	15,234	105,624
	2,722,518	1,385,119	8,986,601	479,610	203,857	1,316,004

Month.	Producers and Refiners.	Emery.	Buckeye Macksburg.	Franklin.	Other lines.	Total.
January	211,056	28,883	312,343	2,869	254,079	2,103,509
February	174,701	24,667	250,718	1,409	203,532	1,773,632
March	218,802	29,900	333,010	3,868	287,174	2,245,177
April	218,754	33,892	319,231	4,046	276,280	2,271,018
May	199,085	30,002	312,580	2,916	248,330	2,131,921
June	186,741	30,839	317,154	3,191	257,444	2,153,470
July	212,253	32,474	328,286	3,692	256,620	2,211,697
August	124,627	29,317	124,196	2,791	218,356	1,216,397
September	166,329	30,435	206,858	3,405	235,439	1,760,930
October	205,548	30,211	379,182	2,702	249,548	2,329,973
November	174,871	26,652	268,374	3,652	220,370	1,895,464
December	178,871	29,991	282,329	2,302	230,162	2,007,860
	2,271,638	357,263	3,434,261	36,843	2,907,334	24,101,048

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Pipe line runs of Appalachian oil in 1914 and 1915, in barrels—Continued.

1915.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	New York Transit.	Tidewater.
January	216,106	103,123	712,263	34,898	14,840	108,203
February	210,492	107,585	690,994	34,255	14,307	98,243
March	233,653	113,592	772,896	38,204	17,085	115,561
April	247,587	118,377	725,307	38,995	15,774	118,852
May	220,977	111,122	693,722	37,271	16,964	108,380
June	241,036	115,474	714,724	35,459	15,737	115,360
July	243,640	110,722	700,258	32,643	16,544	114,327
August	231,908	107,648	685,436	32,504	14,819	111,416
September	221,887	104,758	673,533	30,930	15,321	107,734
October	216,618	102,547	641,894	29,297	15,885	112,133
November	202,857	103,355	645,151	31,926	13,679	101,154
December	208,379	102,429	712,673	30,701	14,436	111,715
	2,695,140	1,300,732	8,368,851	407,083	185,411	1,323,128

Month.	Producers and Refiners.	Emery.	Buckeye Macksburg.	Franklin.	Other lines.	Total.
January	173,678	27,864	278,611	3,485	225,454	1,898,525
February	167,678	27,332	263,134	2,937	216,644	1,833,601
March	180,889	29,323	290,294	3,353	244,251	2,039,101
April	178,163	30,185	281,413	3,595	244,294	2,002,542
May	167,993	27,976	266,878	2,813	228,593	1,882,709
June	171,502	30,005	279,891	3,196	241,394	1,963,778
July	180,666	29,310	268,175	3,241	245,149	1,944,675
August	169,876	26,933	266,566	1,941	235,167	1,884,214
September	170,452	27,782	263,270	2,177	250,342	1,868,186
October	168,735	26,581	270,254	4,901	242,573	1,831,468
November	159,925	27,039	264,463	3,062	245,231	1,787,842
December	173,632	28,255	282,385	6,639	262,163	1,923,407
	2,063,189	338,585	3,265,334	41,340	2,871,255	22,860,048

STOCKS.

Stocks of petroleum held by eastern pipe lines[a] *in the Appalachian field at end of each month in 1914 and 1915, in barrels.*

1914.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	Southern.	Crescent.
January	1,127,661	733,347	1,486,059	65,572	731,646	83,930
February	1,135,148	657,483	1,536,586	74,720	606,027	108,811
March	1,164,164	637,841	1,691,961	82,080	757,806	139,531
April	1,208,151	745,112	1,957,151	111,186	738,647	139,456
May	1,198,170	822,172	2,139,878	136,924	910,047	178,143
June	1,196,361	967,685	2,215,571	184,973	1,012,470	158,723
July	1,132,875	808,226	2,349,260	188,118	865,394	145,395
August	1,221,133	841,382	2,112,931	190,208	930,281	168,439
September	1,128,972	749,656	1,993,544	198,249	813,883	165,545
October	943,637	653,555	1,910,074	199,644	913,368	158,330
November	904,971	679,807	1,697,302	189,306	819,551	102,805
December	956,538	780,698	1,783,682	172,375	710,731	73,963

Month.	New York Transit.	Tidewater.	Northern.	Producers and Refiners.	Emery.	Buckeye Macksburg.
January	762,818	309,750	615,170	367,418	17,432	389,586
February	810,724	312,048	663,242	372,895	15,938	411,145
March	847,049	327,103	734,934	438,892	16,217	436,541
April	854,826	373,713	733,333	520,403	9,192	467,133
May	933,594	375,755	512,891	568,197	9,576	458,039
June	1,247,617	381,435	568,461	599,024	9,336	539,000
July	1,589,268	405,547	684,972	672,950	11,409	541,163
August	1,518,780	373,631	944,625	675,924	15,784	637,202
September	1,019,070	428,347	614,455	652,097	21,497	607,923
October	791,470	415,876	576,769	648,443	11,743	587,306
November	826,876	391,144	598,528	671,612	12,025	624,794
December	743,821	335,601	553,937	694,855	13,282	655,476

[a] These pipe lines connect with the delivering lines of the Illinois, Kansas, and Oklahoma fields and receive and transfer large quantities of these western oils to the Atlantic seaboard in addition to the oil from wells directly tributary to their own systems.

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Stocks of petroleum held by eastern pipe lines in the Appalachian field at end of each month in 1914 and 1915, in barrels—Continued.

1914—Continued.

Month.	Buckeye Lima.	Indiana.	Franklin.	Other lines.	Total.
January	2,197,467	874,459	51,842	679,347	10,493,504
February	2,269,440	875,452	46,231	672,744	10,568,634
March	1,975,677	935,761	47,036	699,887	10,932,780
April	1,986,567	887,902	51,062	736,003	11,519,857
May	2,091,565	980,194	53,998	704,137	12,073,280
June	2,108,760	979,504	57,189	727,216	12,973,325
July	2,188,854	964,662	60,881	684,975	13,293,938
August	2,055,083	989,535	63,182	679,536	13,417,656
September	2,213,788	1,048,003	66,098	660,226	12,381,353
October	2,228,181	1,092,504	•64,443	640,221	11,835,563
November	1,983,571	1,129,443	68,091	614,454	11,314,280
December	1,830,616	1,176,566	65,353	615,574	11,163,068

1915.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	Southern.	Crescent.
January	938,322	733,683	1,691,675	173,340	524,982	105,969
February	953,606	669,059	1,677,590	162,124	505,687	137,307
March	964,244	692,848	1,582,528	143,588	506,286	117,635
April	1,069,871	690,087	1,625,385	149,449	523,058	111,601
May	1,026,914	571,682	1,303,009	120,362	614,063	71,554
June	1,050,772	554,427	1,587,754	108,600	520,545	59,484
July	1,096,922	631,076	1,652,493	112,804	501,815	71,921
August	1,059,720	663,713	1,596,685	120,068	568,418	58,605
September	974,752	528,025	1,759,586	139,088	459,629	65.042
October	978,336	504,534	2,001,451	149,315	463,725	66,431
November	911,649	528,775	1,826,944	158,683	757,544	60,328
December	872,039	607,356	2,074,858	169,259	698,654	92,895

Month.	New York Transit.	Tidewater.	Northern.	Producers and Refiners.	Emery.	Buckeye Macksburg.
January	842,900	754,766	584,468	710,779	14,004	705,144
February	828,436	716,208	710,656	746,384	11,855	743,327
March	917,880	708,285	635,381	777,079	9,619	750,380
April	1,084,815	662,415	600,745	802,653	13,129	685,072
May	1,143,824	622,852	630,266	818,940	13,855	680,490
June	955,324	531,757	525,712	827,437	14,061	538,243
July	1,473,660	630,729	620,811	845,010	15.453	536,792
August	1,374,598	630,796	519,367	811,486	26,087	497,289
September	1,333,714	607,775	588,490	815,494	27,000	597,678
October	1,212,387	712,059	501,121	805,818	31,881	520,479
November	981,556	791,162	556,614	701,469	40,659	617,992
December	1,061,910	763,819	575,869	710,324	45,583	614,501

Month.	Buckeye Lima.	Indiana.	Franklin.	Other lines.	Total.
January	1,999,987	1,180,830	67,142	230,197	11,258,138
February	1,964,235	1,361,887	70,097	206,536	11,464,994
March	2,060,798	1,322,233	73,481	290,216	11,552,481
April	2,269,932	1,136,828	77,235	388,329	11,890,604
May	2,270,441	1,144,857	80,173	371,012	11,494,294
June	2,649,171	1,107,097	83,848	429,172	11,543,404
July	2,431,251	1,127,270	85,030	802,848	12,725,885
August	2,053,110	1,154,797	86,557	1,062,721	12,284,017
September	2,161,397	1,172,262	86,245	1,126,848	12,442,925
October	2,272,331	1,185,596	69,394	1,125,024	12,599,782
November	2,293,598	1,159,820	49,179	1,180,624	12,616,591
December	2,235,796	1,015,814	49,459	1,332,913	12,921,054

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Stocks of all grades of petroleum held by eastern pipe lines[a] in the Appalachian field at end of each month in 1914 and 1915, in barrels.

1914.

Month.	Pennsylvania.[b]	Lima.	Illinois.	Kentucky.	Mid-Continent.	Total.
Dec. 31, 1913	4,387,718	1,623,461	1,079,468	230,706	2,569,305	9,890,658
January	4,482,439	1,831,827	1,456,253	232,090	2,490,895	10,493,504
February	4,470,816	1,881,800	1,419,369	225,872	2,570,777	10,568,634
March	4,941,110	1,718,887	1,487,104	177,760	2,607,919	10,932,780
April	5,646,948	1,750,829	1,165,935	249,564	2,697,581	11,519,857
May	5,949,379	1,714,716	1,161,763	208,713	3,038,709	12,073,280
June	6,428,702	1,818,457	1,015,977	273,525	3,436,664	12,973,325
July	•6,550,281	1,833,687	974,675	309,762	3,625,533	13,293,938
August	6,454,986	1,884,896	992,796	327,891	3,757,187	13,417,656
September	6,063,005	1,919,635	928,276	345,504	3,124,933	12,381,353
October	5,721,833	1,889,850	864,867	398,642	2,960,371	11,835,563
November	5,445,718	1,762,658	824,571	336,951	2,944,382	11,314,280
December	5,436,576	1,648,615	1,016,937	288,119	2,772,821	11,163,068

1915.

January	5,261,676	1,699,059	1,199,716	322,119	2,775,568	11,258,138
February	5,155,769	1,831,184	1,382,970	331,453	2,763,618	11,464,994
March	5,337,948	1,962,851	1,082,045	233,822	2,915,815	11,552,481
April	5,354,181	2,161,666	876,380	286,364	3,211,513	11,890,604
May	5,148,402	2,359,187	642,987	313,160	3,030,558	11,494,294
June	5,096,191	2,573,005	762,845	272,888	2,838,475	11,543,404
July	5,112,932	2,818,675	1,129,139	227,984	3,437,155	12,725,885
August	4,849,224	2,885,176	1,033,608	251,698	3,264,311	12,284,017
September	5,034,594	2,945,678	990,508	280,550	3,191,595	12,442,925
October	5,036,354	3,021,197	1,262,246	215,111	3,064,874	12,599,782
November	5,199,828	3,011,261	1,308,058	227,234	2,870,210	12,616,591
December	5,488,553	2,918,648	1,550,703	252,943	2,710,207	12,921,054

[a] These pipe lines connect with the delivering lines of the Illinois, Kansas, and Oklahoma fields and receive and transfer large quantities of these western oils to the Atlantic seaboard in addition to the oil from wells directly tributary to their own systems.

[b] Includes natural lubricating oil from Pennsylvania and West Virginia.

DELIVERIES TO TRADE.

Pipe-line runs and deliveries to trade of petroleum from the Appalachian field in 1914 and 1915 and stocks at end of each month, in barrels.

Month.	1914			1915		
	Runs.	Deliveries.	Stocks.	Runs.	Deliveries.	Stocks.
Dec. 31, 1913	.....	.....	4,618,424	.....	.....	.....
January	2,103,509	2,007,404	4,714,529	1,898,525	2,039,425	5,583,795
February	1,773,632	1,791,473	4,696,688	1,833,601	1,930,174	5,487,222
March	2,245,177	1,822,995	5,118,870	2,039,101	1,954,553	5,571,770
April	2,271,018	1,493,376	5,896,512	2,002,542	1,933,267	5,641,045
May	2,131,921	1,870,341	6,158,092	1,882,709	2,062,192	5,461,562
June	2,153,470	1,609,335	6,702,227	1,963,778	2,056,261	5,369,079
July	2,211,697	2,053,881	6,860,043·	1,944,675	1,972,838	5,340,916
August	1,216,397	1,293,663	6,782,777	1,884,214	2,114,206	5,110,922
September	1,760,930	2,135,198	6,408,509	1,868,186	1,663,964	5,315,144
October	2,329,973	2,618,007	6,120,475	1,831,468	1,895,147	5,251,465
November	1,895,464	2,233,270	5,782,669	1,787,842	1,612,245	5,427,062
December	2,007,860	2,065,834	5,724,695	1,923,407	1,608,973	5,741,496
	24,101,048	22,994,777	.....	22,860,048	22,843,247	.....

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Pipe-line deliveries to trade of eastern pipe lines[a] in 1914 and 1915, in barrels.

1914.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	Southern.	Crescent.
January	1,199,081	109,880	69,565	1,098	548,833	130,246
February	1,048,592	107,945	59,711	2,681	326,174	97,343
March	1,198,689	130,730	72,932	3,510	207,704	.....
April	1,098,369	105,220	65,432	3,090	139,499	26,198
May	969,837	124,064	70,950	6,972	189,326	104,181
June	1,262,292	158,812	62,061	6,497	55,341	171,481
July	1,262,047	128,188	80,832	4,016	108,181	178,003
August	651,395	93,761	81,637	3,083	8,966	.....
September	847,135	132,379	80,716	1,396	345,708	39,186
October	566,846	155,135	80,217	6,950	429,386	128,603
November	361,781	138,419	70,460	423	318,985	178,267
December	371,276	126,604	78,851	1,643	359,885	181,474
	10,837,340	1,510,157	873,384	41,299	3,037,988	1,244,934

Month.	New York Transit.	Tidewater.	Producers and Refiners.	Emery.	Buckeye Macksburg.	Franklin.
January	996,759	168,411	197,947	28,241	.....	9,419
February	984,701	152,732	169,331	26,160	.....	7,019
March	1,241,650	152,348	158,119	29,622	.....	3,104
April	1,162,945	154,178	137,373	40,926	.....	.....
May	1,078,402	141,701	153,562	29,609	244	.....
June	704,942	152,754	154,851	31,078	.....	.....
July	785,606	139,505	135,655	30,402	1,689	.....
August	392,457	145,725	117,788	24,942	.....	489
September	844,232	93,840	191,786	24,721	.....	489
October	1,103,741	200,361	213,860	39,965	.....	4,357
November	623,827	242,728	261,373	26,371	.....	4
December	312,654	182,892	154,163	28,734	.....	5,040
	10,231,916	1,927,175	2,045,807	360,771	1,933	29,921

1915.

Month.	National Transit.	Southwest Pennsylvania.	Eureka.	Cumberland.	Southern.	Crescent.
January	458,395	120,500	64,122	278	346,283	120,419
February	371,949	117,846	75,956	18	272,466	109,230
March	397,281	143,502	66,098	21	296,897	173,458
April	433,869	144,985	61,524	584	265,951	154,130
May	405,839	137,312	66,097	1,212	241,779	201,122
June	398,331	127,988	63,565	478	292,982	157,092
July	468,849	159,813	58,692	806	316,980	114,655
August	504,914	164,273	68,848	483	309,123	148,719
September	506,190	156,776	76,229	706	170,439	129,193
October	449,989	147,570	60,791	431	162,561	148,454
November	401,068	149,922	67,464	10,670	227,876	154,373
December	433,698	161,958	69,909	2,833	153,442	120,308
	5,229,372	1,732,445	799,295	17,920	3,056,779	1,731,153

Month.	New York Transit.	Tidewater.	Producers and Refiners.	Emery.	Buckeye Macksburg.	Franklin.
January	274,188	178,867	157,639	27,142	.....	9,476
February	284,859	141,408	132,426	29,482	.....	.....
March	237,321	181,742	149,594	31,559	.....	432
April	328,616	201,715	159,218	26,675	.....	.....
May	411,381	151,359	151,697	27,250	990	.....
June	372,709	242,219	163,657	29,799	1,464	4
July	499,814	142,878	163,602	27,918	.....	1,774
August	692,741	197,585	199,921	19,300	.....	493
September	603,577	200,101	164,024	23,868	.....	661
October	467,694	151,725	181,864	21,699	.....	23,592
November	543,972	135,874	264,274	18,261	.....	22,809
December	592,914	139,256	164,769	23,326	.....	6,360
	5,309,786	2,064,729	2,052,685	306,279	2,454	65,601

[a] These pipe lines connect with the delivering lines of the Illinois, Kansas, and Oklahoma fields and receive and transfer large quantities of these western oils to the Atlantic seaboard in addition to the oil from wells directly tributary to their own systems.

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PRICES OF APPALACHIAN OIL.

Prices paid at wells by the Seep Purchasing Agency for petroleum produced in the Appalachian field in 1913, 1914, and 1915, per barrel.

Date.	Pennsylvania and Tiona, Pa.	Mercer black, Pennsylvania.	Corning, Ohio.	New Castle, Ohio.	Wooster, Ohio.	Cabell, W. Va.	Somerset, Ky. (light).	Ragland, Ky. (heavy).
1913.								
Jan. 1	$2.00	$1.53	$1.53	$1 53	$1.53	$1.60	$1.15	$0.65
Jan. 6	2.05	1.58	1.58	1.58	.....	1.65	1.20	.68
Jan. 7	.....	.....	.....	.....	1.58	.....	.....	.....
Jan. 27	2.12	1.65	1.65	1.65	1.65	1.72	1.25	.....
Jan. 28	2.19	1.72	1.72	1.72	.....	1.79	1.30	.....
Jan. 29	2.26	1.79	1.79	1.79	1.72	1.86	1.32	.70
Jan. 30	2.33	1.86	1.86	1.86	1.79	1.93	.....	.....
Jan. 31	.....	.....	.....	.....	1.86	.....	.....	.....
Feb. 1	2.40	1.93	1.93	1.93	.....	2.00	.....	.....
Feb. 4	2.47	2.00	2.00	2.00	.....	2.07	1.35	.....
Feb. 5	2.50	.....	.....	.....	.....	.....	.....	.....
Apr. 15	.....	.....	.....	.....	1.91	.....	.....	.....
1914.								
Jan. 1	2.50	2.00	2.00	2.00	1.91	2.07	1.35	.70
Apr. 17	2.40	1.90	1.75	1.90	.....	1.97	.....	.....
Apr. 18	.....	.....	.....	.....	1.81	.....	.....	.....
Apr. 20	2.30	1.80	1.50	1.80	.....	1.87	1.30	.....
Apr. 22	2.20	1.70	1.35	1.70	.....	1.77	1.25	.65
Apr. 25	.....	.....	.....	.....	1.71	.....	.....	.....
Apr. 27	2.10	1.60	1.25	1.60	.....	1.67	1.20	.....
Apr. 28	.....	.....	.....	.....	1.61	.....	.....	.....
Apr. 29	.....	.....	.....	.....	.....	.....	1.10	.....
Apr. 30	2.00	1.50	1.15	1.50	.....	1.57	.....	.....
May 1	.....	.....	.....	.....	1.51	.....	.....	.....
May 11	1.90	1.40	1.05	1.40	1.46	1.47	1.05	.....
June 1	1.80	1.35	1.00	1.35	.....	1.40	.....	.....
June 16	1.75	1.30	.....	1.30	.....	1.35	.....	.70
June 17	.....	.....	.....	.....	1.43	.....	.....	.....
July 15	1.70	1.27	.....	1.27	.....	1.32	1.02	.....
July 28	1.65	1.22	.....	1.22	.....	1.25	1.00	.....
July 29	.....	.....	.....	.....	1.38	.....	.....	.....
Aug. 1	.....	.....	.....	.....	1.33	.....	.....	.....
Aug. 7	.....	.....	.....	.....	1.28	.....	.....	.....
Aug. 8	1.60	1.17	.95	1.17	.....	1.20	.95	.....
Aug. 12	1.55	1.12	.90	1.12	.....	1.15	.90	.67
Aug. 17	1.50	1.07	.87	1.07	.....	1.10	.87	.....
Aug. 20	1.45	1.02	.85	1.02	.....	1.05	.85	.65
Sept. 15	.....	.....	.....	.....	1.23	.....	.....	.....
Sept. 23	.....	.....	.....	.....	1.18	.....	.....	.....
Oct. 26	.....	.....	.....	.....	1.15	.....	.....	.....
1915.								
Jan. 1	1.45	1.02	.85	1.02	1.15	1.05	.85	.65
Jan. 4	1.50	1.07	.95	1.07	.....	1.10	.90	.70
Feb. 16	.....	.....	.....	.....	1.10	.....	.....	.....
Mar. 15	1.45	1.02	.90	1.02	.....	1.05	.85	.65
Mar. 20	1.40	1.00	.85	1.00	.....	1.00	.83	.....
Apr. 3	1.35	.97	.83	.97	.....	.97	.80	.63
Apr. 18	.....	.....	.....	.....	1.05	.....	.....	.....
Aug. 13	1.45	1.07	93	1.07	.....	1.07	.90	.....
Aug. 17	1.55	1.17	1.03	1.17	.....	1.17	1.00	.65
Aug. 20	.....	.....	.....	.....	1.10	.....	.....	.....
Aug. 23	.....	.....	.....	.....	1.15	.....	.....	.....
Aug. 24	1.60	1.20	1.06	1.20	.....	1.20	1.03	.....
Sept. 4	.....	.....	.....	.....	1.20	.....	.....	.....
Sept. 13	1.65	1.23	1.12	1.23	.....	1.25	1.08	.....
Sept. 15	.....	.....	.....	.....	1.25	.....	.....	.....
Sept. 27	1.70	1.26	1.18	1.26	.....	1.30	1.12	.....
Oct. 7	1.75	.....	1.25	.....	.....	.....	1.17	.....
Oct. 25	.....	.....	.....	.....	1.30	.....	.....	.....
Oct. 27	1.80	1.30	1.30	1.30	.....	.....	1.22	.....
Nov. 5	1.85	1.35	1.35	1.35	.....	1.35	1.27	.68
Nov. 15	1.90	1.40	1.40	1.40	1.35	1.40	1.32	.70
Nov. 17	.....	.....	.....	.....	1.40	.....	.....	.....
Nov. 18	2.00	1.50	1.50	1.50	.....	1.59	1.42	.....
Dec. 3	2.10	1.60	1.60	1.60	1.45	1.60	1.50	.....
Dec. 15	.....	.....	.....	.....	1.50	.....	.....	.....
Dec. 17	2.15	1.65	1.65	1.65	.....	1.70	1.55	.72
Dec. 30	2.25	1.75	1.75	1.75	.....	1.78	1.63	.75

NOTE.—In addition to these prices bonuses ranging from 2 to 10 cents a barrel were paid by various pipe lines and refineries.

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Average monthly prices of Appalachian petroleum in 1914 and 1915, per barrel.

1914.

Month.	Pennsylvania and Tiona, Pa.	Mercer black, Pennsylvania.	Corning, Ohio.	New Castle, Ohio.	Wooster, Ohio.	Cabell, W. Va.	Somerset, Ky.	Ragland, Ky.
January	$2.50	$2.00	$2.00	$2.00	$1.91	$2.07	$1.35	$0.70
February	2.50	2.00	2.00	2.00	1.91	2.07	1.35	.70
March	2.50	2.00	2.00	2.00	1.91	2.07	1.35	.70
April	2.37	1.87	1.73	1.87	1.84	1.94	1.30	.69
May	1.93	1.43	1.07	1.43	1.48	1.50	1.07	.65
June	1.78	1.33	1.00	1.33	1.45	1.38	1.05	.68
July	1.72	1.28	1.00	1.28	1.43	1.32	1.03	.70
August	1.54	1.11	.91	1.11	1.29	1.14	.90	.67
September	1.45	1.02	.85	1.02	1.24	1.05	85	.65
October	1.45	1.02	.85	1.02	1.17	1.05	.85	.65
November	1.45	1.02	.85	1.02	1.15	1.05	.85	.65
December	1.45	1.02	.85	1.02	1.15	1.05	.85	.65
Average	1.88	1.43	1.26	1.43	1.49	1.47	1.07	.67

1915.

January	$1.50	$1.07	$0.94	$1.07	$1.15	$1.10	$0.90	$0.70
February	1.50	1.07	.95	1.07	1.13	1.10	.90	.70
March	1.45	1.04	.90	1.04	1.10	1.05	.86	.67
April	1.35	.97	.83	.97	1.08	.97	.80	.63
May	1.35	.97	.83	.97	1.05	.97	.80	.63
June	1.35	.97	.83	.97	1.05	.97	.80	.63
July	1.35	.97	.83	.97	1.05	.97	.80	.63
August	1.47	1.09	.95	1.09	1.08	1.09	.92	.64
September	1.64	1.23	1.10	1.23	1.22	1.24	1.07	.65
October	1.75	1.27	1.24	1.27	1.26	1.30	1.17	.65
November	1.91	1.41	1.41	1.41	1.32	1.41	1.33	.69
December	2.12	1.62	1.62	1.62	1.47	1.64	1.52	.71
Average	1.56	1.14	1.04	1.14	1.16	1.15	.99	.66

Monthly and yearly average prices of pipe-line certificates of petroleum of Pennsylvania grade at wells in daily market, 1906–1915, per barrel.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
1906	$1.58	$1.58	$1.58	$1.60⅜	$1.64	$1.64	$1.63⅜	$1.58	$1.58	$1.58	$1.58	$1.58	$1.598
1907	1.58	1.61½	1.72⅞	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.745
1908	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.780
1909	1.78	1.78	1.78	1.78	1.70	1.67½	1.60½	1.58	1.58	1.56½	1.49	1.44⅜	1.646
1910	1.40⅜	1.40	1.40	1.36⅛	1.35	1.31⅜	1.30	1.30	1.30	1.30	1.30	1.30	1.336
1911	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.31	1.301
1912	1.41	1.50	1.50	1.52	1.55	1.59	1.60	1.60	1.60	1.60	1.75	1.96	1.598
1913	2.07	2.49	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.463
1914	2.50	2.50	2.50	2.37	1.93	1.78	1.72	1.54	1.45	1.45	1.45	1.45	1.889
1915	1.50	1.50	1.45	1.35	1.35	1.35	1.35	1.47	1.64	1.75	1.91	2.12	1.563

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Highest and lowest prices of crude petroleum of Pennsylvania grade, 1859–1915, per barrel.

Year.	Highest.		Lowest.	
	Month.	Price.	Month.	Price.
1859	September	$20.00	December	$20.00
1860	January	20.00	do	2.00
1861	do	1.75	do	.10
1862	December	2.50	January	.10
1863	do	4.00	do	2.00
1864	July	14.00	February	3.75
1865	January	10.00	August	4.00
1866	do	5.50	December	1.35
1867	October	4.00	June	1.50
1868	July	5.75	January	1.70
1869	January	7.00	December	4.25
1870	do	4.90	August	2.75
1871	June	5.25	January	3.25
1872	October	4.55	December	2.67½
1873	January	2.75	November	.85½
1874	February	2.25	do	.62½
1875	do	1.82½	January	.75
1876	December	4.23½	do	1.47½
1877	January	3.60½	June	1.53½
1878	February	1.87½	September	.78½
1879	December	1.28½	June	.62½
1880	June	1.24½	April	.71½
1881	September	1.01½	July	.72½
1882	November	1.37	do	.49½
1883	June	1.24½	January	.83½
1884	January	1.15½	June	.51½
1885	October	1.12½	January	.68
1886	January	.92½	August	.50½
1887	December	.90	July	.54
1888	March	1.00	June	.71½
1889	November	1.12½	April	.79½
1890	January	1.07½	December	.60½
1891	February	.81½	August	.50
1892	January	.64½	October	.50
1893	December	.80	January	.52½
1894	do	.95½	do	.78½
1895	April	2.60	do	.95½
1896	January	1.50	December	.90
1897	March	.96	October	.65
1898	December	1.19	January	.65
1899	do	1.66	February	1.13
1900	January	1.68	November	1.05
1901	January, September	1.45	May	.80
1902	December	1.54	January, February, March	1.15
1903	do	1.90	January, February, March, April, May, June, July.	1.50
1904	January	1.85	July, December	1.50
1905	October	1.61	May	1.27
1906	April, May, June, July	1.64	January, February, March, April, August, September, October, November, December.	1.58
1907	March to December, inclusive.	1.78	January	1.58
1908	No change	1.78	No change	1.78
1909	January, February, March	1.78	December	1.43
1910	January	1.43	June to December, inclusive	1.30
1911	December	1.35	January to December	1.30
1912	do	2.00	January	1.35
1913	March to December, inclusive.	2.50	do	2.00
1914	January to March, inclusive	2.50	September to December, inclusive	1.45
1915	December	2.15	April to August, inclusive	1.35

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SUMMARY OF WELLS DRILLED IN APPALACHIAN FIELD.

The statistics of field operations presented in the following tables are compiled from trade journal sources and differ somewhat from those on pages 55 to 60, which were taken from reports received directly from the oil producers:

Wells completed in the Appalachian field, 1911–1915.

State.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Pennsylvania and New York	1,491	1,911	3,420	2,247	1,409	297	322	521	338	284	2,007	2,472	4,251	2,869	1,906
Southeastern and central Ohio	765	846	1,246	863	677	512	460	603	517	472	1,680	1,717	2,191	2,044	1,910
West Virginia	622	1,062	1,285	1,043	763	218	234	339	347	246	1,191	1,657	2,065	1,758	1,289
Kentucky	100	112	133	119	56	33	61	69	55	36	136	178	210	178	92
	2,978	3,931	6,084	4,272	2,905	1,060	1,077	1,532	1,257	1,038	5,014	6,024	8,717	6,849	5,197

[a] Including gas wells.

Oil wells and dry holes drilled in the Appalachian field in 1915.

State.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Pennsylvania and New York	75	18	67	17	95	14	105	17	101	26	99	24	123	29
Southeastern and central Ohio	55	42	39	29	49	42	58	40	50	36	50	31	47	36
West Virginia	54	26	55	24	63	27	56	18	76	16	60	22	60	20
Kentucky	1	3	3	4	4	1	5	.....	10	9	5	6	4	2
	185	89	164	74	211	84	224	75	237	87	214	83	234	87

State.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Pennsylvania and New York	132	33	116	38	182	26	179	28	135	14	1,409	284
Southeastern and central Ohio	51	52	54	27	61	35	79	54	84	48	677	472
West Virginia	65	18	66	17	63	21	73	25	72	12	763	246
Kentucky	3	1	2	1	5	3	6	4	8	2	56	36
	251	104	238	83	311	85	337	111	299	76	2,905	1,038

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Wells completed in the Appalachian field, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	188	182	317	445	185	81	73	96	117	89	347	311	513	649	408
February	180	173	318	364	164	86	43	111	123	74	345	260	528	574	367
March	168	223	394	321	211	90	82	106	88	84	326	360	585	464	395
April	196	300	466	524	224	82	65	126	137	75	352	427	675	734	390
May	249	346	541	531	237	82	78	112	141	87	405	491	727	770	407
June	277	397	632	489	214	91	79	139	135	83	440	573	829	734	382
July	274	386	569	463	234	101	98	139	121	87	459	570	786	738	407
August	288	429	595	375	251	115	121	155	113	104	472	636	846	615	455
September	290	396	580	198	238	77	140	142	76	83	459	670	814	427	414
October	292	386	601	197	311	90	102	132	70	85	483	622	855	388	505
November	300	352	565	177	337	83	100	121	69	111	491	562	793	385	586
December	276	361	506	188	299	82	96	153	57	76	435	542	766	371	481
	2,978	3,931	6,084	4,272	2,905	1,060	1,077	1,532	1,257	1,038	5,014	6,024	8,717	6,849	5,197

[a] Including gas wells.

Initial daily production of new wells in the Appalachian field in 1915, in barrels.

State.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Pennsylvania and New York	208	216	234	275	405	969	1,527	1,726	830	921	1,440	569	9,320
Southeastern and central Ohio	658	642	493	534	723	777	466	345	782	675	901	1,377	8,373
West Virginia	1,670	814	1,685	1,112	1,177	753	1,276	981	1,079	699	1,360	895	13,501
Kentucky	1	122	33	119	128	24	14	25	6	53	30	173	728
	2,537	1,794	2,445	2,040	2,433	2,523	3,283	3,077	2,697	2,348	3,731	3,014	31,922

Total and average initial daily production of new wells in the Appalachian field, 1911–1915, by States, in barrels.

State.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Pennsylvania and New York	4,912	6,771	8,958	6,627	9,320	3.29	3.54	2.62	2.95	6.61
Southeastern and central Ohio	10,923	24,193	16,302	12,047	8,373	14.28	28.60	13.08	13.96	12.37
West Virginia	10,443	109,804	34,835	24,474	13,501	16.79	103.39	27.11	23.47	17.69
Kentucky	1,822	1,943	2,215	1,568	728	18.22	17.35	16.65	13.18	13.00
	28,100	142,711	62,310	44,716	31,922	9.44	36.30	10.24	10.47	10.99

Total initial daily production of new wells in the Appalachian field, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911	1,916	2,349	1,694	2,036	2,708	1,933	2,222	2,444	2,470	2,417	3,354	2,557	28,100	2,342
1912	4,417	10,835	11,523	18,781	22,986	22,836	16,199	9,751	6,466	6,758	4,251	7,908	142,711	11,893
1913	4,768	5,816	5,223	6,283	4,510	7,464	4,412	5,162	4,423	5,626	4,557	4,066	62,310	5,193
1914	4,787	4,256	4,452	4,190	5,141	4,312	4,102	3,420	2,256	3,776	1,976	2,048	44,716	3,726
1915	2,537	1,794	2,445	2,040	2,433	2,523	3,283	3,077	2,697	2,348	3,731	3,014	31,922	2,660

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PENNSYLVANIA.

GENERAL STATEMENT.

Deprived of the necessary spur of prices high enough to warrant wildcat drilling during the part of the year when drilling activity is normally at its height, development work in the oil fields of western Pennsylvania was almost entirely restricted to areas of proved worth. That the output credited to the State in 1915 represents a decline of only 4 per cent from that in 1914 and of only 1 per cent from that in 1913 and a slight increase over that in 1912 is due chiefly to the extraordinary success attending the redrilling of certain areas all but abandoned years ago, but in part to the marketing late in the year of appreciable quantities of oil that had gradually been accumulated in producers' tanks during the period of low prices. The steady upward movement of prices for grades of oil produced in Pennsylvania during the fall and winter, though coming too late to affect production in 1915, will undoubtedly inspire a great amount of wildcat drilling in 1916, as well as a more thorough development of proved areas.

DEVELOPMENT.

Inclusive of the New York division of the Bradford district a total of 1,808 wells were completed in 1915 in the Pennsylvania districts, a decrease of 794 in total completions, compared with 1914, and of 1,934, compared with 1913. The results of the repressed activity in 1915 included 1,333 oil wells, 195 gas wells, and 280 dry holes, the ratio between dry holes and total completions being about 1 to 6 for the entire State.

The combined output of the new oil wells, considering only the yield for the first day of productive life was 9,198 barrels, an average of 6.9 barrels for each well. This average, which is notably higher than that attained by new wells in Pennsylvania for many years, is due entirely to activities in the Butler-Armstrong and southwestern Pennsylvania districts, which are fully described in subsequent paragraphs.

Bradford district.—In the old Bradford district a total of 348 wells were completed, including 313 oil wells, 24 gas wells, and only 11 dry holes. Nearly one-half the completions were made during the last four months of the year. The caution with which drilling operations were carried on in this district is apparent from the fact that no dry holes were reported in the months of March, April, May, September, October, and November, and by the remarkable ratio of 1 to 31 maintained between dry holes and total completions. Activity in the search for natural gas was more pronounced than that for oil during the first seven months of 1915, but conditions were reversed during the succeeding months. Interest in gas development was centered in the vicinity of Red House, on the Allegheny Indian Reservation, in the New York division, where a number of creditable wells were completed. Interest in oil development was well sustained in the area about Rew and Coleville, McKean County, Pa., where oil wells above the average in production were completed late in the year. Near Eldred the discovery of oil in paying quantities in the Kane sand by the Windfall Gas Co. inspired additional drilling in the Windfall district. In the almost abandoned Gaines field, in western Tioga County, a revival of activity was reported late in the

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fall near Watrous. The combined initial output of all oil wells completed in the Bradford district in 1915 was 1,019 barrels, an average of 3.3 barrels per well.

Middle district.—In the productive areas in Warren, Forest, and Elk counties activity in the search for both oil and gas was nominal in 1915. The gas field discovered near Ridgway, Elk County, in February, 1914, was fairly well defined in that year, but furnished a few good wells in 1915. A total of 182 wells were completed in this district, of which 159 yielded an average initial output of 2.2 barrels of oil each, 7 were classed as gassers, and 16 were barren. The ratio of dry holes to total completions in this district was as 1 to 11.

Venango-Clarion district.—More wells were completed in the Venango-Clarion district than in any other district in Pennsylvania, despite a loss of 36 per cent in total completions compared with 1914. Of 595 wells completed 458, or 77 per cent, produced oil, though the total initial production amounted to only 629 barrels, or an average of 1.4 barrels for each well. New work in 1915 was well distributed throughout the productive area and resulted in no important discoveries or extensions.

Butler-Armstrong district.—To the results of drilling activity in the Butler-Armstrong district belongs a part of the credit for the fact that the Pennsylvania yield of oil in 1915 fell but slightly below the output in 1914. Operations in this district were decidedly apathetic until May, when the completion by McClay, Martin, and others, of an oil well rated at 125 barrels of initial production on the parsonage lot of the Lutheran Church at Evans City, Butler County, provided the incentive for one of the most frantic town-lot developments of recent years. The importance of this well lay not only in its size but in the fact that it confirmed the results obtained in a well rated as a 25-barrel producer completed in April by Plaisted & McCandless on the John Kreitzberger farm and demonstrated beyond question the presence of a pool of oil in the third sand in a locality where previous development had been restricted largely to the shallower hundred-foot sand. Subsequent developments rapidly defined the new pool, which proved to extend but little beyond the boundaries of the town site, and essentially exhausted its production before the end of the year. Some 150 wells were drilled in this pool where 40, appropriately spaced, would have been ample to recover all the oil.

Aside from the forced drilling at Evans City, activity in the Butler-Armstrong district was relatively slight and resulted in no important discoveries. The district as a whole is credited with 324 completions in 1915, of which 224 were oil wells, 16 were gassers, and 84 were barren. New production amounted to 4,288 barrels, or an average of 19 barrels for each oil well the first day of productive life. The ratio of dry holes to total completions averaged as 1 to 4.

Southwestern Pennsylvania.—In the productive areas of southwestern Pennsylvania activity in the search for new production was considerably below normal, falling off, in fact, about 50 per cent as compared with 1914. In all 359 wells were completed in this district, of which 179 produced oil, the combined initial production amounting to 2,908 barrels, or an average of about 16 barrels for each well. Gas wells numbered 77 and dry holes 103, an average of 2 in every 7 wells completed and an indication of the reason why high prices for crude petroleum are necessary before additional drilling in these old fields is justified.

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The most successful development in this district in 1915 was in the old Dorseyville field, in Indiana Township, Allegheny County, which was extended to the north and east in the last half of 1915 as a consequence of a successful advance test completed by Walley & Co. on the McCorkle farm early in the year. Subsequent tests adjacent to this well resulted in gushers up to 600 barrels in initial flow from the 30-foot sand and made this area the most attractive locality in southwestern Pennsylvania at the end of the year.

In July considerable excitement was aroused near East McKeesport, Versailles Township, Allegheny County, by the completion on the Spiegel farm of what has been termed "the largest gas well ever struck in Pennsylvania." When completed the well was estimated to have an open-flow capacity of 60,000,000 cubic feet a day. For several days this monster gas well ran wild, but it was eventually shut in by the Peoples Natural Gas Co., of Pittsburgh, which purchased the output from the local company that drilled the well. Within a month the output of this well dropped to 4,000,000 cubic feet a day and within two months the flow was essentially exhausted. Other wells, of which there were a dozen or more drilled in the vicinity of this gusher, proved barren or were ordinary producers.

NEW YORK.

The tardy recovery of the petroleum market and the scarcity of undeveloped or even untested territory furnished in 1915 a combination of adverse conditions that resulted in a decided suppression of activity in the search for oil in the old Allegany district and in the New York division of the Bradford district. The search for natural gas was, however, unabated and gave the fields an appearance of moderate activity and resulted in the incidental completion of a number of oil wells of small capacity. In the Allegany district 76 oil wells were completed, an average rate of 3 wells every two weeks, the combined initial yield of which was 122 barrels, an average of less than 2 barrels a well.

Late in December considerable interest was aroused by the completion near Canisteo, Steuben County, 20 miles east of the Allegany district, of a freak well, which from a depth of 695 feet yielded for a few days a small quantity of amber-colored petroleum reported to have a gravity of 52° B. and to contain 85 per cent of gasoline. Other wells drilled subsequently in the same locality were barren.

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COMBINED STATISTICS OF PENNSYLVANIA AND NEW YORK FIELDS.

MARKETED PRODUCTION.

Petroleum marketed in Pennsylvania and New York, 1911–1915, in barrels.

Pennsylvania.

Month.	1911	1912	1913	1914	1915
January	697,290	562,665	669,134	677,284	629,588
February	637,719	575,180	577,763	532,826	615,005
March	722,755	686,178	637,250	726,605	672,343
April	701,489	699,856	703,829	782,378	697,036
May	765,470	728,127	700,585	701,685	638,490
June	704,082	657,545	661,542	724,172	683,410
July	668,324	678,789	688,065	731,080	682,583
August	704,627	675,848	653,090	646,412	655,242
September	661,775	634,114	651,046	688,761	654,036
October	690,360	686,184	693,996	704,024	645,333
November	622,543	610,314	609,033	614,126	623,955
December	671,724	643,148	671,979	640,982	641,684
	8,248,158	7,837,948	7,917,302	8,170,335	7,838,705

New York.

January	83,160	64,850	80,906	78,963	74,101
February	73,007	63,080	66,969	62,424	67,755
March	83,226	73,371	74,592	80,660	79,840
April	81,239	79,188	82,580	88,268	79,018
May	88,594	82,035	83,742	84,548	75,114
June	84,442	73,950	77,819	84,110	76,406
July	75,885	75,875	83,237	84,783	79,012
August	81,368	74,663	78,005	75,512	72,531
September	76,263	68,884	78,594	76,102	72,914
October	78,469	76,766	84,480	81,569	72,399
November	70,101	68,045	74,437	71,593	66,218
December	76,761	73,421	82,830	70,422	72,468
	952,515	874,128	948,191	938,974	887,778

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade-journal sources and differ somewhat from those on page 587, which are obtained from reports received directly from the oil producers.

Wells completed in the Pennsylvania and New York oil fields, 1911–1915.

District.	Oil.					Dry.					Total completed. [a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Bradford	260	335	675	455	313	16	14	31	28	11	298	371	755	531	348
Allegany	128	177	441	215	76	9	17	22	17	4	194	246	509	267	98
Middle	208	226	352	207	159	39	36	66	17	16	247	266	435	290	182
Venango and Clarion	642	853	1,352	813	458	93	90	141	68	66	805	1,019	1,578	936	595
Butler and Armstrong	124	138	354	183	224	65	59	110	81	84	219	216	497	284	324
Southwestern Pennsylvania	129	182	246	374	179	75	106	151	127	103	244	354	477	621	359
	1,491	1,911	3,420	2,247	1,409	297	322	521	338	284	2,007	2,472	4,251	2,869	1,906

[a] Including gas wells.

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Oil wells and dry holes drilled in the Pennsylvania and New York oil fields in 1915.

District.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Bradford	15	1	16	1	21	.....	31	.....	28	.....	18	1	19	1
Allegany	4	.....	5	.....	1	.....	4	.....	9	.....	7	1	8	.....
Middle	1	.....	4	.....	9	.....	14	1	6	1	19	3	13	.....
Venango and Clarion	25	2	26	2	35	4	29	6	29	7	30	6	35	11
Butler and Armstrong	7	4	5	5	10	5	17	2	11	6	12	9	36	10
Southwestern Pennsylvania	23	11	11	9	19	5	10	8	18	12	13	4	12	7
	75	18	67	17	95	14	105	17	101	26	99	24	123	29

District.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Bradford	17	6	32	.....	38	.....	47	.....	31	1	313	11
Allegany	3	.....	6	2	11	.....	8	1	10	.....	76	4
Middle	13	1	11	2	25	1	21	5	23	2	159	16
Venango and Clarion	39	6	40	8	64	7	60	6	46	1	458	66
Butler and Armstrong	48	13	16	11	25	8	23	7	14	4	224	84
Southwestern Pennsylvania	12	7	11	15	19	10	20	9	11	6	179	103
	132	33	116	38	182	26	179	28	135	14	1,409	284

Wells completed in the Pennsylvania and New York oil fields, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	68	73	153	220	75	22	21	26	29	18	100	112	205	271	104
February	60	71	129	164	67	25	11	27	37	17	96	91	183	216	103
March	52	90	204	139	95	23	19	36	24	14	87	125	268	179	114
April	84	150	248	303	105	33	23	48	39	17	130	190	329	355	135
May	117	181	303	296	101	33	30	37	42	26	168	232	363	366	151
June	152	210	375	286	99	28	29	49	42	24	198	266	439	356	138
July	148	191	352	273	123	19	28	53	30	29	191	237	431	340	172
August	168	224	344	209	132	32	42	57	22	33	222	284	427	261	190
September	170	190	335	115	116	22	37	56	24	38	205	252	416	163	172
October	157	190	356	94	182	22	26	45	18	26	210	242	431	133	228
November	174	167	341	83	179	25	37	37	17	28	227	228	406	123	230
December	141	174	280	75	135	13	19	50	14	14	173	213	353	106	169
	1,491	1,911	3,420	2,247	1,409	297	322	521	338	284	2,007	2,472	4,251	2,869	1,906

[a] Including gas wells.

Total and average initial daily output of new wells in the Pennsylvania and New York oil fields, 1911–1915, by districts, in barrels.

District.	Total initial production.					Average initial production per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Bradford	730	817	1,676	1,588	1,019	2.81	2.44	2.48	3.49	3.26
Allegany	201	278	820	446	122	1.57	1.57	1.86	2.07	1.61
Middle	541	511	649	586	354	2.60	2.26	1.84	2.83	2.23
Venango and Clarion	1,302	1,943	2,301	1,263	629	2.03	2.28	1.70	1.55	1.37
Butler and Armstrong	422	696	1,487	684	4,288	3.40	5.04	4.20	3.74	19.14
Southwestern Pennsylvania	1,716	2,526	2,025	2,060	2,908	13.30	13.88	8.23	5.51	16.25
	4,912	6,771	8,958	6,627	9,320	3.29	3.54	2.62	2.95	6.61

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Total initial daily yield of new wells in the Pennsylvania and New York oil fields 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911.....	204	345	154	313	319	368	435	611	517	507	695	444	4,912	409
1912.....	548	621	613	657	531	588	482	637	720	530	474	370	6,771	564
1913.....	426	387	733	638	729	959	838	860	826	891	869	802	8,958	746
1914.....	618	527	476	928	764	706	741	727	300	247	334	259	6,627	552
1915.....	208	216	234	275	405	969	1,527	1,726	830	921	1,440	569	9,320	777

Total daily output of new wells completed in Pennsylvania and New York in 1915, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Bradford.....	49	43	62	93	88	60	90	45	123	119	147	100	1,019
Allegany.....	6	6	1	5	11	13	10	6	7	21	14	22	122
Middle.....	5	8	20	17	18	23	88	34	30	34	42	35	354
Venango and Clarion.	27	50	37	55	41	43	48	48	51	79	85	65	629
Butler and Armstrong.....	19	51	42	46	171	760	1,253	1,553	116	148	74	55	4,288
Southwestern Pennsylvania.....	102	58	72	59	76	70	38	40	503	520	1,078	292	2,908
	208	216	234	275	405	969	1,527	1,726	830	921	1,440	569	9,320

WEST VIRGINIA.

GENERAL STATEMENT.

A marketed production of 9,264,798 barrels of petroleum, valued at $14,468,278, reflects the conditions, inherited from 1914, that prevailed in West Virginia in 1915. This output is in the main very creditable, as it records a decrease of only 415,235 barrels, or 4 per cent, from the output in 1914 and suggests that normal activity might have reversed the moderate decrease noted.

DEVELOPMENT.

A total of 1,289 wells was completed in West Virginia in 1915, of which number 763, or 59 per cent, produced oil and 280, or 22 per cent, produced gas, the remaining 246, or 19 per cent, being barren.

The combined output of the oil wells completed during the year for the first day of productive life amounted to 13,501 barrels, an average of 17.7 barrels per well. Marion County led in the number of completions in 1915 with a total of 181 new oil wells to its credit; but Kanawha County easily retained first rank on the basis of new production, its 86 new oil wells furnishing 4,724 barrels of the initial production credited to the entire State during the year. The position of Kanawha County in this regard is due to the fact that the famous Blue Creek field is still capable of furnishing wells of larger capacity than the average found in other parts of the State, and to the further fact that the new pool discovered in December, 1914, near the mouth of Laurel Run, in the Cabin Creek district, contributed 10 wells that averaged more than 100 barrels each the first day of productive life.

Aside from this development in Cabin Creek district, which attracted little attention from companies other than the Columbus Producing

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Co., which controls the development and the surrounding acreage, interest in prospective areas of production was divided between Green district, Wetzel County, where deeper drilling on Fishing Creek, near the town of Minnie, resulted in the partial development of a promising pool of oil in the Big Injun sand, and Clay district, Monongalia County, where drilling for gas unexpectedly developed oil in paying quantities in the Big Injun sand in the vicinity of Mooresville.

In strictly wildcat territory a small producing well was reported late in the year on Clymer Creek, Curry district, Putnam County, and in September the efforts of the South Penn Oil Co. to develop a Berea sand pool in Butler district, Wayne County, on the Kentucky border, were rewarded with a 10-barrel well in an area where previous tests had been disappointing.

In December the completion of a small oil well 2 miles west of the old Murphytown pool, in Clay district, Wood County, revived interest in the possibilities of a new pool in the vicinity of Parkersburg.

The recovery of the petroleum market came too late in the year to affect appreciably drilling activity in 1915, but the substantial nature of the advance in oil prices early in the winter guarantees a thorough testing of promising territory in all parts of West Virginia in 1916.

MARKETED PRODUCTION.

Petroleum marketed in West Virginia, 1911–1915, in barrels.

Month.	1911	1912	1913	1914	1915
January	814,743	694,619	978,401	855,896	777,702
February	800,712	801,699	936,733	770,300	754,034
March	881,172	983,502	970,900	919,377	848,926
April	810,661	1,018,955	1,026,129	900,998	801,046
May	882,093	1,153,945	1,003,425	864,519	767,685
June	832,920	1,172,331	995,098	872,074	789,545
July	787,171	1,174,367	1,009,393	897,065	780,749
August	838,922	1,190,552	939,479	272,098	761,111
September	773,024	981,052	928,610	675,518	752,751
October	795,687	1,013,980	956,772	985,724	716,638
November	757,029	918,313	893,274	799,728	720,267
December	821,330	1,025,647	983,095	866,746	794,344
	9,795,464	12,128,962	11,567,299	9,680,033	9,264,798

Petroleum marketed in West Virginia, 1906–1915, in barrels.

Year.	Regular crude.			Lubricating.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1906	10,111,647	$16,138,811	$1.596	9,288	$31,482	$3.39	10,120,935	$16,170,293	$1.598
1907	9,089,839	15,834,714	1.740	5,457	17,714	3.25	9,095,296	15,852,428	1.743
1908	9,519,875	16,902,968	1.775	3,301	8,897	2.70	9,523,176	16,911,865	1.776
1909	10,742,026	17,634,335	1.642	3,066	7,948	2.59	10,745,092	17,642,283	1.642
1910	11,751,018	15,717,796	1.338	2,053	5,748	2.80	11,753,071	15,723,544	1.338
1911	9,792,324	12,757,861	1.302	3,140	9,432	3.00	9,795,464	12,767,293	1.303
1912	12,126,137	19,919,952	1.643	2,825	7,769	2.75	12,128,962	19,927,721	1.643
1913	11,562,730	28,813,822	2.492	4,569	14,982	3.28	11,567,299	28,828,814	2.492
1914	9,677,553	18,462,175	1.908	2,480	6,365	2.56	9,680,033	18,468,540	1.908
1915	9,260,914	14,458,513	1.561	3,884	9,765	2.51	9,264,798	14,468,278	1.561

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SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade journal sources and differ somewhat from those on page 587, which are obtained from reports received directly from the oil producers.

Wells completed in West Virginia, 1911–1915.

County.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Brooke	1	5	28	15	4	2	4	6	16	10	3	9	38	40	21
Cabell	1	.....	.....	.....	.....	2	.....	1	.....	.....	5	.....	1	.....	.....
Calhoun	11	19	18	5	3	2	12	6	6	1	33	38	32	17	10
Clay	.....	.....	.....	9	14	.....	.....	.....	4	.....	.....	.....	.....	16	17
Gilmer	.....	.....	.....	12	15	.....	.....	.....	8	10	.....	.....	.....	23	32
Hancock	8	5	21	16	5	.....	11	7	6	7	8	16	33	23	13
Kanawha	(b)	440	177	114	86	(b)	11	20	17	6	(b)	486	227	153	105
Lincoln	58	61	66	59	88	3	1	4	8	.....	68	70	75	105	96
Marion	98	80	230	311	181	39	39	51	81	33	280	298	526	535	357
Marshall	.....	.....	.....	7	.....	.....	.....	.....	3	2	.....	.....	.....	18	9
Pleasants	60	59	108	74	71	29	31	42	25	24	90	91	150	102	100
Ritchie	93	79	129	125	53	45	20	39	49	49	170	121	191	190	117
Roane	160	147	253	115	64	8	13	21	15	16	194	169	295	152	99
Wetzel and Tyler	43	66	105	81	97	34	48	61	48	50	135	183	242	199	185
Wirt	22	17	49	53	53	5	3	8	24	15	31	21	60	78	72
Wood	49	61	71	47	25	31	20	36	16	15	80	81	108	63	41
Miscellaneous	18	23	30	.....	4	18	21	37	21	8	94	74	87	44	15
	622	1,062	1,285	1,043	763	218	234	339	347	246	1,191	1,657	2,065	1,758	1,289

[a] Including gas wells. [b] Miscellaneous.

Oil wells and dry holes drilled in West Virginia in 1915.

County.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Brooke	.....	.....	.....	.....	1	2	1	1	.....	.....	.....	1	.....	.....
Calhoun	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Clay	2	.....	.....	.....	1	.....	2	.....	.....	.....	.....	.....	3	.....
Gilmer	1	1	1	1	.....	1	2	.....	4	1	.....	.....	1	2
Hancock	.....	.....	1	1	1	1	2	.....	.....	1	.....	1	1	.....
Kanawha	8	.....	4	.....	8	.....	8	.....	9	.....	5	.....	6	.....
Lincoln	3	.....	3	.....	4	.....	5	.....	3	.....	4	.....	3	.....
Marion	13	4	12	4	21	5	15	1	27	.....	20	1	17	4
Marshall	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pleasants	5	2	4	2	2	3	4	1	7	1	7	1	8	2
Ritchie	7	5	6	5	2	6	3	6	8	3	3	6	5	3
Roane	4	3	6	3	10	3	3	2	3	1	8	1	3	.....
Wetzel and Tyler	4	8	5	5	7	4	6	2	10	5	8	5	9	6
Wirt	2	1	11	1	2	.....	3	3	4	2	4	3	3	1
Wood	4	1	2	1	4	1	2	1	.....	.....	1	2	1	1
Miscellaneous	1	1	.....	.....	.....	1	.....	1	1	2	.....	1	.....	1
	54	26	55	24	63	27	56	18	76	16	60	22	60	20

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Oil wells and dry holes drilled in West Virginia in 1915—Continued.

County.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Brooke	1	2	.....	2	.....	1	.....	1	1	.....	4	10
Calhoun	2	.....	.....	.....	1	.....	.....	.....	.....	.....	3	1
Clay	1	.....	1	.....	1	.....	3	.....	.....	.....	14	.....
Gilmer	.....	.....	4	.....	.....	.....	2	4	.....	.....	15	10
Hancock	.....	.....	.....	1	.....	.....	.....	2	.....	.....	5	7
Kanawha	11	1	6	.....	6	1	10	3	5	1	86	6
Lincoln	9	.....	15	.....	14	.....	9	.....	16	.....	88	.....
Marion	8	2	13	4	9	3	7	2	19	3	181	33
Marshall	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	2
Pleasants	7	2	9	1	3	5	9	3	6	1	71	24
Ritchie	2	5	2	2	5	1	7	5	3	2	53	49
Roane	3	1	5	1	9	1	4	.....	6	.....	64	16
Wetzel and Tyler	14	1	7	2	10	5	10	3	7	4	97	50
Wirt	7	2	1	.....	3	1	6	1	7	.....	53	15
Wood	.....	2	2	2	1	3	6	.....	2	1	25	15
Miscellaneous	.....	.....	1	.....	1	.....	.....	1	.....	.....	4	8
	65	18	66	17	63	21	73	25	72	12	763	246

Wells completed in West Virginia, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	53	54	92	109	54	19	18	21	31	26	102	96	157	165	102
February	47	50	98	102	55	24	14	26	38	24	108	80	157	174	99
March	52	71	91	96	63	21	30	30	33	27	106	119	157	151	110
April	45	75	113	95	56	14	15	25	37	18	100	113	177	165	98
May	56	74	103	137	76	10	12	25	45	16	96	116	163	202	114
June	44	90	138	101	60	12	11	34	37	22	81	134	202	174	99
July	60	108	102	95	60	20	18	30	29	20	105	148	163	156	110
August	51	113	110	82	65	28	23	32	29	18	107	171	175	154	100
September	50	117	104	48	66	19	21	30	20	17	101	185	172	108	100
October	58	96	114	58	63	17	21	28	11	21	98	167	187	97	111
November	46	111	109	54	73	12	15	31	15	25	80	162	173	104	128
December	60	108	111	67	72	22	36	27	22	12	107	166	182	108	118
	622	1,062	1,285	1,043	763	218	234	339	347	246	1,191	1,657	2,065	1,758	1,289

[a] Including gas wells.

Initial daily production of new wells completed in West Virginia in 1915, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Brooke	.....	.....	5	5	.....	.....	.....	2	.....	.....	.....	5	17
Calhoun	.....	.....	.....	.....	.....	.....	.....	3	.....	5	.....	.....	8
Clay	15	.....	3	25	.....	.....	45	10	25	5	133	.....	261
Gilmer	5	5	.....	8	22	.....	10	.....	29	.....	30	.....	109
Hancock	.....	20	5	2	.....	.....	5	.....	.....	.....	.....	.....	32
Kanawha	975	176	983	360	285	173	300	285	242	245	534	216	4,724
Lincoln	15	35	53	57	13	44	40	108	110	127	89	130	821
Marion	136	147	405	313	635	259	138	145	451	127	172	235	3,163
Pleasants	21	30	4	42	97	28	61	98	41	23	59	47	551
Ritchie	119	77	3	45	35	16	85	15	14	33	67	27	536
Roane	116	178	72	22	15	98	35	35	30	28	41	26	696
Wetzel and Tyler	105	77	180	222	52	116	534	229	120	82	159	151	2,027
Wirt	102	66	16	5	18	18	22	51	5	14	38	55	410
Wood	11	3	6	6	.....	1	1	.....	2	5	38	3	76
Miscellaneous	50	.....	.....	.....	5	.....	.....	.....	10	5	.....	.....	70
Total	1,670	814	1,685	1,112	1,177	753	1,276	981	1,079	699	1,360	895	13,501

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Total and average initial daily production of new wells in West Virginia, 1911–1915, by counties, in barrels.

County.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Brooke	3	19	1,329	186	17	3.00	3.80	47.46	12.40	4.25
Cabell	5	(a)	12	.....	.....	5.00	.....	.....	.....	.....
Calhoun	295	340	199	22	8	26.82	17.90	11.06	4.40	2.67
Clay	.....	(a)	(a)	84	261	.....	.....	.....	9.33	18.64
Gilmer	.....	.....	.....	71	109	.....	.....	.....	5.92	7.27
Hancock	29	21	82	105	32	3.63	4.20	3.90	6.56	6.40
Kanawha	(a)	98,870	10,703	8,965	4,724	.....	224.70	60.47	78.64	54.93
Lincoln	1,087	1,058	929	797	821	18.74	17.34	14.08	13.51	9.33
Marion	2,180	2,001	6,829	9,532	3,163	22.24	25.01	29.69	30.65	17.48
Marshall	.....	.....	.....	92	.....	.....	.....	.....	13.14	.....
Pleasants	374	930	2,045	455	551	6.23	15.76	18.93	6.15	7.76
Ritchie	1,661	726	968	1,545	536	17.86	9.19	7.50	12.36	10.11
Roane	3,243	3,161	9,185	931	696	20.27	21.50	36.30	8.10	10.88
Wetzel and Tyler	661	1,292	1,995	1,085	2,027	15.37	19.58	16.14	13.40	20.90
Wirt	144	105	212	437	410	6.54	6.18	4.33	8.25	7.73
Wood	337	318	482	167	76	6.88	5.21	6.79	3.55	3.04
Miscellaneous	424	963	165	.....	70	23.56	41.87	5.50	.....	17.50
	10,443	109,804	34,835	24,474	13,501	16.79	103.39	27.11	23.47	17.69

a Included in "Miscellaneous."

Total initial daily production of new wells in West Virginia, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911	813	938	773	869	991	767	1,015	834	700	865	1,008	870	10,443	870
1912	2,010	6,602	8,577	15,925	19,930	19,926	13,528	6,383	4,586	3,901	2,606	5,740	109,804	9,150
1913	3,428	3,988	3,144	4,121	2,360	5,085	1,846	2,527	1,846	2,452	1,795	2,243	34,835	2,903
1914	2,178	2,173	2,287	1,741	2,475	2,768	2,263	1,677	1,369	2,850	1,336	1,357	24,474	2,040
1915	1,670	814	1,685	1,112	1,177	753	1,276	981	1,079	699	1,360	896	13,501	1,125

KENTUCKY.

GENERAL STATEMENT.

The dullness in the oil industry of Kentucky in 1915 is reflected in the quantity of production credited to this State, which was 13 per cent less than in 1914 and considerably below the corresponding output in any other year since 1902. The retarding influence was largely the market price of oil, which, though normally lower for grades produced in Kentucky than for other Appalachian oils, was exceptionally low in 1915 and offered little inducement to activity even in proved areas and none to wildcat drilling, where the hazards and costs are much greater.

Somerset grade, which includes the bulk of the oil produced in Kentucky, reached its lowest market quotation of 80 cents a barrel on April 3 and remained at that price until August 13, when it began a steady advance that reached $1.63 a barrel before the close of 1915 and $1.95 a barrel before the end of March, 1916. The price of Ragland grade produced in the Ragland pool in Bath and Rowan counties, which was 65 cents a barrel at the beginning of 1915, advanced to 70 cents on January 4, but declined to a low level of 63 cents, which was maintained from April 3 to August 17 and was succeeded by advances that carried it to 75 cents a barrel before December 31.

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The early arrival of winter prevented these advances from appreciably affecting the production of oil in Kentucky in 1915 but inspired a confidence on the part of the producers that is certain to result in an extensive drilling campaign throughout the State in 1916.

DEVELOPMENT.

Field activity in Kentucky attained about one-half its usual proportions in 1915 and was notably limited to areas of proved worth. Only 92 wells were completed, and of these only 56 were oil wells, the remaining 36 being barren. Initial production amounted to 728 barrels, an average of 13 barrels for each oil well the first day of productive life—no appreciable decrease from the average in 1914.

Despite the repression of activity the year was not without its developments of interest to the local industry. The most important feature of this character was the rejuvenation of the old Irvine pool, in Estill County, or rather the extension of its productive limits about 6 miles to the northeast. The restoration of temporary shipping facilities to this pool, pending the reconstruction of a branch pipe line from Cannel City or Lewis to Irvine by the Cumberland Pipe Line Co. in December, stimulated activity in the new extension, which is destined to give a good account of itself in 1916.

In the Scottsville-Petroleum district, Allen County, which has no market outlet other than the railroads, little activity was reported until late in the year, when the price of oil had advanced to a point where rail shipment became feasible. Before December 31 several good wells had been completed in this district, one of which was a mile beyond any other productive well. Late in 1915 several small properties in this field were consolidated under the control of the well-known Illinois operators, Snowden Bros., who plan a thorough development in 1916. Oil produced in this district is shipped in tank cars to refineries at Lawrenceville, Ill., Louisville, Ky., and Nashville, Tenn.

In Edmonson County the completion of an oil well of small capacity in April attracted little attention in an area remote from marketing facilities.

The encouraging results obtained in two small wells in Daviess County, near the Indiana boundary, in 1914, resulted in the drilling of three additional wells in 1915, all of which were barren.

MARKETED PRODUCTION.

Petroleum marketed in Kentucky, 1911–1915, in barrels.

Month.	1911	1912	1913	1914	1915
January	33,237	38,425	42,074	46,930	34,898
February	31,151	37,723	36,843	44,545	35,707
March	37,910	40,923	39,391	53,860	39,562
April	35,484	37,875	39,036	50,465	40,015
May	42,906	44,967	42,932	44,903	39,323
June	38,509	40,311	39,285	44,361	37,070
July	42,237	44,997	48,211	42,630	35,905
August	44,087	40,866	49,908	26,758	37,531
September	44,356	39,146	52,538	21,177	34,929
October	41,556	38,484	46,301	51,625	33,564
November	40,818	40,000	44,137	36,900	34,702
December	40,207	41,151	43,912	38,287	34,068
	472,458	484,368	524,568	502,441	437,274

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Pipe-line runs in Kentucky in 1914 and 1915, in barrels.

1914.

Month ending—	Cooper.	Griffin (Denney).	Parmleysville.	Steubenville.	Total, Wayne County.	Beaver Creek.	Busseyville.
Jan. 31	6,427	15,578	5,393	2,898	30,296	1,256	1,574
Feb. 28	5,633	14,371	3,390	4,558	27,952	1,044	879
Mar. 28	5,677	15,157	3,254	5,650	29,738	1,565	840
Apr. 25	7,288	15,530	5,010	7,704	35,532	1,235	1,743
May 30	5,065	11,426	3,267	5,698	25,456	1,269	1,219
June 27	5,518	9,912	3,283	5,244	23,957	869	1,534
July 25	7,327	11,985	3,899	6,076	29,287	1,504	1,654
Aug. 29	3,707	6,106	2,131	3,398	15,342	365	963
Sept. 26	2,604	3,236	1,108	1,675	8,623	592	698
Oct. 31	7,814	11,211	4,695	6,796	30,516	1,455	3,202
Nov. 28	5,470	7,517	2,918	4,233	20,138	822	2,395
Jan. 2, 1915	7,159	8,807	3,217	6,004	25,187	1,793	1,956
	69,689	130,836	41,565	59,934	302,024	13,769	18,709

Month ending—	Page Hollow.	Campton.	Ragland.	Stillwater.	Cannel City and Lewis.	Williamsburg.	Total.
Jan. 31	.....	3,741	4,615	327	10,866	.....	52,675
Feb. 28	.....	1,961	2,175	799	6,464	.....	41,274
Mar. 28	.....	2,674	4,255	457	6,921	.....	46,450
Apr. 25	.....	3,113	4,299	.....	9,028	146	55,096
May 30	.....	2,065	3,580	482	5,154	146	39,371
June 27	.....	1,946	3,392	285	5,170	.....	37,153
July 25	.....	2,844	3,826	684	6,528	141	46,468
Aug. 29	.....	841	3,016	137	1,727	.....	22,391
Sept. 26	.....	969	2,550	155	1,979	157	15,723
Oct. 31	.....	3,616	5,549	999	7,906	147	53,450
Nov. 28	.....	2,338	2,384	452	3,526	302	32,347
Jan. 2, 1915	530	1,629	4,340	331	3,330	302	39,400
	530	27,737	43,981	5,108	68,599	1,341	481,798

1915.

Month ending—	Cooper.	Griffin (Denney).	Parmleysville.	Steubenville.	Total, Wayne County.	Beaver Creek.	Busseyville.	Page Hollow.
Jan. 30	5,389	6,666	2,854	4,732	19,641	967	2,018	.....
Feb. 27	5,520	7,201	3,021	5,292	21,034	759	1,685	.....
Mar. 27	4,901	7,110	2,283	7,007	21,301	1,985	2,341	.....
May 1	6,474	8,511	4,304	10,944	30,233	1,040	2,539	.....
May 29	4,782	6,046	3,020	7,306	21,154	1,190	2,264	.....
June 26	4,578	5,470	2,990	6,490	19,528	928	1,986	.....
July 31	5,753	6,705	4,010	7,194	23,662	1,060	3,213	.....
Aug. 28	4,425	4,915	3,050	5,003	17,393	1,199	2,209	.....
Oct. 2	5,530	6,262	3,975	6,697	22,464	967	2,920	.....
Oct. 30	4,457	5,042	3,200	5,104	17,803	895	2,241	393
Nov. 27	4,093	4,263	3,262	4,794	16,412	799	2,107	.....
Jan. 1, 1916	5,698	5,234	3,530	6,468	20,930	682	2,579	.....
	61,600	73,425	39,499	77,031	251,555	12,471	28,192	393

Month ending—	Campton.	Ragland.	Stillwater.	Cannel City.	Irvine.	Williamsburg.	Total.
Jan. 30	2,502	3,032	642	4,416	.....	149	33,367
Feb. 27	2,118	3,955	457	3,122	.....	149	33,279
Mar. 27	1,097	3,314	766	2,746	.....	149	33,699
May 1	2,758	3,731	917	4,295	.....	149	45,662
May 29	1,711	3,722	337	2,056	.....	.....	32,434
June 26	2,174	2,977	1,095	2,515	.....	149	31,352
July 31	2,253	4,624	901	4,278	.....	.....	39,991
Aug. 28	1,975	2,772	920	1,791	.....	.....	28,349
Oct. 2	2,060	4,264	1,000	2,701	.....	149	36,525
Oct. 30	876	2,611	767	1,913	.....	149	27,648
Nov. 27	2,015	1,588	747	2,731	.....	.....	26,399
Jan. 1, 1916	2,704	2,865	979	3,386	727	149	35,001
	24,243	39,455	9,528	35,950	727	1,192	403,706

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SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade journal sources and differ somewhat from those on page 588, which are obtained from reports received directly from the oil producers.

Wells completed in Kentucky, 1911–1915.

County.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Allen	.....	.....	7	16	1	.....	.....	1	1	1	.....	.....	8	19	2
Barren	.....	.....	3	.....	.....	.....	.....	3	.....	.....	.....	.....	6	.....	.....
Cumberland	.....	1	.....	.....	.....	.....	.....	1	.....	.....	.....	1	2	.....	.....
Daviess	.....	.....	.....	2	.....	.....	.....	.....	1	3	.....	.....	.....	3	3
Edmonson	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Estill	.....	.....	.....	3	2	.....	.....	.....	.....	.....	.....	.....	.....	3	2
Floyd	2	4	.....	.....	.....	1	.....	1	1	.....	3	4	1	1	.....
Johnson	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Lawrence	.....	20	9	9	10	1	12	1	.....	2	1	33	11	10	12
Logan	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....
Morgan	.....	.....	33	10	1	.....	.....	13	5	1	.....	.....	48	15	2
Ohio	.....	.....	.....	4	.....	.....	.....	.....	4	.....	.....	.....	.....	8	.....
Wayne	94	75	67	68	31	27	44	31	34	27	121	119	98	102	58
Webster	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
Wolfe	1	9	12	6	10	.....	2	10	4	1	2	11	22	10	11
Other	2	3	3	.....	.....	4	3	8	5	.....	8	10	14	6	.....
	100	112	133	119	56	33	61	69	55	36	136	178	210	178	92

[a] Including gas wells.

Oil wells and dry holes drilled in Kentucky in 1915.

County.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Daviess	.....	2	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Edmonson	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....
Estill	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lawrence	.....	.....	1	.....	.....	.....	.....	.....	2	1	.....	1	1	.....
Morgan	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Wayne	1	.....	2	3	3	1	4	.....	6	8	3	5	2	2
Webster	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wolfe	.....	.....	.....	.....	1	.....	.....	.....	1	.....	2	.....	1	.....
	1	3	3	4	4	1	5	.....	10	9	5	6	4	2

County.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen	.....	.....	.....	.....	.....	.....	.....	.....	1	1	1	1
Daviess	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
Edmonson	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Estill	.....	.....	.....	.....	1	.....	.....	.....	1	.....	2	.....
Lawrence	1	.....	.....	.....	1	.....	3	.....	1	.....	10	2
Morgan	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	1	1
Wayne	1	1	1	.....	2	3	3	3	3	1	31	27
Webster	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Wolfe	1	.....	1	1	1	.....	.....	.....	2	.....	10	1
	3	1	2	1	5	3	6	4	8	2	56	36

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Wells completed in Kentucky, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	6	10	6	11	1	4	3	4	5	3	7	13	11	16	4
February	14	3	15	12	3	5	1	7	7	4	20	6	23	19	7
March	7	14	4	11	4	5	5	4	2	1	12	19	9	13	5
April	6	10	11	14	5	2	1	9	7	.....	8	11	21	21	5
May	11	12	12	8	10	1	3	4	4	9	12	16	17	12	19
June	10	8	9	14	5	1	7	7	8	6	10	15	16	22	11
July	9	6	11	12	4	6	2	6	5	2	14	8	18	18	6
August	8	11	10	14	3	2	7	5	6	1	10	18	17	20	4
September	4	18	19	8	2	.....	17	7	5	1	9	37	26	14	3
October	10	6	11	3	5	3	4	2	3	3	13	10	13	7	8
November	9	9	10	8	6	1	7	4	2	4	12	16	14	10	10
December	6	5	15	4	8	3	4	10	1	2	9	9	25	6	10
	100	112	133	119	56	33	61	69	55	36	136	178	210	178	92

[a] Including gas wells.

Initial daily production of new wells completed in Kentucky in 1915, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Allen	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	50	50
Edmonson	.....	.....	.....	10	.....	.....	.....	.....	.....	.....	.....	.....	10
Estill	.....	.....	.....	.....	.....	.....	.....	.....	.....	25	.....	100	125
Lawrence	.....	12	.....	.....	19	.....	5	10	.....	10	17	5	78
Morgan	.....	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	3
Wayne	1	110	31	109	96	8	7	10	1	13	13	9	408
Wolfe	.....	.....	2	.....	10	16	2	5	5	5	.....	9	54
	1	122	33	119	128	24	14	25	6	53	30	173	728

Total and average initial daily production of new wells in Kentucky, 1911–1915, by counties, in barrels.

County.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Allen	.....	.....	114	335	50	.....	.....	16.28	20.93	50.00
Barren	.....	.....	14	.....	.....	.....	.....	4.66	.....	.....
Cumberland	.....	3	.....	.....	.....	.....	3.0	.....	.....	.....
Daviess	.....	.....	.....	10	.....	.....	.....	.....	5.00	.....
Edmonson	.....	.....	.....	.....	10	.....	.....	.....	.....	10.00
Estill	.....	.....	.....	23	125	.....	.....	.....	7.66	62.50
Floyd	45	35	.....	.....	.....	22.5	8.9	.....	.....	.....
Johnson	.....	.....	.....	10	.....	.....	.....	.....	10.00	.....
Lawrence	.....	148	65	69	78	.....	7.4	7.22	7.66	7.80
Logan	10	.....	.....	.....	.....	10.0	.....	.....	.....	.....
Morgan	.....	.....	967	96	3	.....	.....	30.22	9.60	3.00
Ohio	.....	.....	.....	150	.....	.....	.....	.....	37.50	.....
Wayne	1,729	1,481	723	843	408	18.4	19.7	10.79	12.39	13.16
Wolfe	25	196	107	32	54	25.0	21.8	8.92	5.33	5.40
Other	13	80	225	.....	.....	6.5	26.7	75.00	.....	.....
	1,822	1,943	2,215	1,568	728	18.2	17.3	16.65	13.17	13.00

Total initial daily production of new wells in Kentucky, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911	17	93	101	167	176	89	195	227	358	129	125	145	1,822	152
1912	122	35	341	255	216	255	112	213	121	128	75	70	1,943	162
1913	43	325	105	501	93	138	221	166	192	124	109	198	2,215	185
1914	140	238	148	267	94	122	155	165	120	28	66	25	1,568	131
1915	1	122	33	119	128	24	14	25	6	53	30	173	728	61

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OHIO.

GENERAL STATEMENT.

The total contribution of oil in Ohio to the crude-petroleum industry in 1915 was 7,825,326 barrels, a quantity less by 711,026 barrels, or 8 per cent, than in 1914. Of the output in 1915 the Lima or northwestern district contributed 43 per cent and the southeastern-central district 57 per cent. No important areas of new production were discovered in 1915, the output credited to the State being derived wholly from areas previously proved. The rate of decline in output registered in 1915 is about double the normal rate and is due to the fact that drilling activity throughout the oil districts was abnormally low, as a consequence of which the new production developed was insufficient to offset the normal decline in yield of the oil wells. As this condition of repressed activity was due wholly to low prices for crude petroleum and not to the absence of undrilled territory of promise in and adjacent to the developed fields, the reversal of market conditions during the last four months of 1915 may be accepted as indicating that in 1916 the Ohio fields will be given the opportunity of making good the discrepancy recorded against them in 1915.

The average price received for all grades of oil produced in Ohio in 1915 was $1.29 a barrel, the product of the northwestern division averaging 97 cents a barrel and that of the southeastern-central division $1.53 a barrel for the year. Compared with 1914 these prices are appreciably lower, the difference amounting to 28 cents for the State and to 22 and 33 cents, respectively, for the two major divisions.

DEVELOPMENT.

Field activity in Ohio in 1915 was distributed over 25 counties in the southeastern-central division and 12 counties in the northwestern division. A total of 2,171 wells were completed, including 901 oil wells, 771 gas wells, and 499 dry holes, the ratio of failures to total completions being as 3 to 13.

Southeastern-central division.—In the many productive districts of eastern and central Ohio 1,910 wells were completed in 1915, of which 677, or 35 per cent, were oil wells; 761, or 40 per cent, were gassers; and 472, or 25 per cent, were barren. Initial oil production amounted to 8,373 barrels, an average of 12 barrels per well.

The so-called "shallow sand" district of southeastern Ohio, where oil is obtained from strata of the Carboniferous system, maintained a moderate activity throughout the year. In this district drilling costs are not excessive and the hazards are reduced by the presence of a number of oil sands, one or more of which may prove productive in any well drilled. In this district Washington County easily led in activity and in new production, the areas in Newport and Marietta townships furnishing a number of creditable wells during the year.

In the "deep sand" district of south-central Ohio, where oil is obtained from the "Clinton" sand, interest was well sustained in the vicinity of Union Furnace, Hocking County, by the completion of a number of wells ranging in initial capacity from 100 to 350 barrels each, in an area whose limits have not yet been fully determined. Efforts to extend the area of "Clinton sand" production southward into Vinton County were sufficiently successful to cause new drilling

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which should furnish conclusive results in 1916. Toward the north, desultory operations in Muskingum, Perry, and Licking counties failed to add new territory to the developed pools.

Late in 1915 the advancing oil market caused a marked increase in wildcat activity in this part of the State in the search for new pools of "Clinton sand" production comparable with the Bremen, Wooster, and Sugar Grove pools. That this search may be successful in 1916 is suggested by the encouraging results of one test in Holmes County, east of Brinkhaven, that was completed before the end of the year and credited with a capacity of 100 barrels of oil the first day of productive life.

In northern Ohio activity was pronounced throughout 1915 in the quest of natural gas. The Cleveland field that came into prominence in 1914 was the center of activity and furnished the majority of the gas wells completed in Ohio in 1915. Drilling on lots within the city limits, which was so objectionable a feature of operations in this area in 1914, gradually subsided with the exhaustion of productive territory there, but became more pronounced to the west and southwest of the city, in which direction the field was proved to extend and where acreage tracts were available for development. Incidental to the gas development, petroleum was found in commercial quantities in a few of the wells. Marketing facilities were provided by the Buckeye Pipe Line Co. by the establishment of the Cleveland division, and during December runs to the amount of 477 barrels were made from this territory.

In northeastern Ohio the discovery in September of oil in a wildcat test drilled by the Mutual Development Co. on the Drury farm at Saybrook, near Ashtabula, Ashtabula County, attracted considerable attention. The capacity of the well was rated at 15 barrels a day and the production was reported to be derived from a sandstone at a depth of 2,450 feet. Other wells were immediately started in the vicinity, but only one was completed before the close of 1915. This was located on the Wilkinson farm about 1½ miles southwest of the discovery well and was completed in November, at approximately the same depth as the Drury well, as a gas well estimated to have an open-flow capacity of 3,000,000 cubic feet a day.

Northwestern division.—In the old Lima field of northwestern Ohio activity in the search of new production reached about one-third its normal proportions. Of 261 new wells completed during the year 224, or 86 per cent, were oil wells, 10 were gassers, and 27 were barren. The combined initial output of the oil wells was 4,496 barrels, or an average of 20 barrels for each well, which is from 5 to 9 barrels higher than the corresponding yield of new wells in this division in any year since 1901.

This increase is due almost entirely to the success attending development in Seneca County, where the average initial output per well was increased from 31 barrels in 1914 to 91 barrels in 1915. More specifically the credit for this increase should go to the Tiffin district, in which the Sun Co. completed several wells on the county infirmary farm that averaged more than 100 barrels in initial flow and one well, No. 15, finished early in September, that was credited with a yield of 750 barrels the first 24 hours after completion.

In Wood County noteworthy success attended drilling in sections 12 and 13, Liberty Township, where a number of wells above the average in initial capacity were completed on the Killian and Rudolph

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farms near Mermill, as a consequence of which the average initial output of all wells completed in that county was raised from 13 barrels in 1914 to 18 barrels in 1915.

Development work in other counties of northwestern Ohio was largely routine in character, the new wells having in the main a lower average initial yield than in 1914.

At the end of 1915 there were approximately 30,784 active oil wells in Ohio, compared with 31,864 at the end of 1914.

MARKETED PRODUCTION.

Petroleum marketed in Ohio in 1911–1915, in barrels.

Month.	Lima.				
	1911	1912	1913	1914	1915
January	395,132	254,382	336,665	341,162	271,437
February	364,706	245,764	275,831	229,310	274,450
March	413,321	316,946	279,117	343,414	311,095
April	380,434	366,846	349,204	338,745	313,775
May	405,705	380,394	333,866	329,256	283,022
June	393,385	354,165	317,476	331,060	295,378
July	367,216	365,227	327,556	337,431	291,978
August	383,440	358,260	319,486	319,529	275,442
September	365,586	322,245	319,443	312,202	276,998
October	376,118	353,881	332,902	314,526	228,632
November	330,800	313,361	296,090	275,469	261,197
December	360,032	[a] 324,426	329,317	254,983	260,429
	4,535,875	[a] 3,955,897	3,817,043	3,727,087	3,393,833

Month.	Southeastern Ohio.				
	1911	1912	1913	1914	1915
January	346,170	333,489	407,538	444,426	382,236
February	341,747	356,983	364,307	363,537	361,100
March	372,270	443,795	324,699	464,675	398,430
April	345,162	440,834	456,072	448,909	385,427
May	383,774	453,807	420,757	436,266	362,097
June	371,118	416,396	414,698	428,753	377,345
July	341,329	439,748	424,588	456,139	366,426
August	364,138	460,361	410,459	195,617	357,799
September	352,353	410,131	425,023	299,372	353,556
October	358,100	437,877	456,364	507,031	363,534
November	343,691	397,129	406,018	373,117	342,700
December	361,385	422,560	453,902	391,423	380,843
	4,281,237	5,013,110	4,964,425	4,809,265	4,431,493

Month.	Total.				
	1911	1912	1913	1914	1915
January	741,302	587,871	744,203	785,588	653,673
February	706,453	602,747	640,138	592,847	635,550
March	785,591	760,741	603,816	808,089	709,525
April	725,596	807,680	805,276	787,654	699,202
May	789,479	834,201	754,623	765,522	645,119
June	764,503	770,561	732,174	759,813	672,723
July	708,545	804,975	752,144	793,570	658,404
August	747,578	818,621	729,945	515,146	633,241
September	717,939	732,376	744,466	611,574	630,554
October	734,218	791,758	789,356	821,557	642,166
November	674,491	710,490	702,108	648,586	603,897
December	721,417	746,986	783,219	646,406	641,272
	8,817,112	8,969,007	8,781,468	8,536,352	7,825,326

[a] Includes production of Michigan.

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Quantity, value, and average price per barrel of petroleum produced in Ohio, 1906–1915.

Year.	Lima.			Southeastern Ohio.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1906....	9,881,184	$9,157,641	$0.926	4,906,579	$7,839,359	$1.597	14,787,763	$16,997,000	$1.149
1907....	7,993,057	7,425,480	.929	4,214,391	7,344,406	1.742	12,207,448	14,769,888	1.209
1908....	6,748,676	6,861,885	1.016	4,110,121	7,316,617	1.780	10,858,797	14,178,502	1.305
1909....	5,915,357	5,451,497	.921	4,717,436	7,773,880	1.647	10,632,793	13,225,377	1.243
1910....	5,094,136	4,181,629	.821	4,822,234	6,469,939	1.341	9,916,370	10,651,568	1.074
1911....	4,535,875	3,888,119	.857	4,281,537	5,591,423	1.306	8,817,112	9,479,542	1.075
1912....	[a] 3,955,897	3,908,809	.988	5,013,110	8,177,189	1.628	8,969,007	12,085,998	1.347
1913....	3,817,043	5,308,842	1.391	4,964,425	12,229,610	2.463	8,781,468	17,538,452	1.997
1914....	3,727,087	4,435,314	1.190	4,809,265	8,937,415	1.858	8,536,352	13,372,729	1.567
1915....	3,393,833	3,300,833	.973	4,431,493	6,760,660	1.526	7,825,326	10,061,493	1.286

[a] Includes production of Michigan.

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade journal sources and differ somewhat from those on page 588, which are obtained from reports received directly from the oil producers:

Wells completed in central and southeastern Ohio, 1911–1915.

County.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Ashland	.....	.....	1	2	1	12	34	21	15	27	100	131	118	88	88
Athens	.....	3	15	7	16	.....	5	12	8	4	.....	10	28	19	21
Belmont	.....	9	21	15	12	.....	3	29	24	13	.....	13	58	55	34
Carroll	10	5	21	29	24	20	5	22	7	13	36	11	44	38	41
Columbiana	14	4	28	58	37	30	13	18	12	28	44	17	47	72	64
Coshocton	7	9	15	13	.....	7	1	.....	5	.....	17	10	18	18	.....
Cuyahoga	1	4	.....	7	13	.....	4	1	35	68	2	19	4	384	515
Delaware	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	.....	.....	.....
Erie	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	.....	.....	2	.....
Fairfield	57	25	44	25	12	35	19	28	13	7	115	60	91	44	23
Guernsey	.....	.....	11	.....	.....	.....	.....	22	2	.....	.....	.....	33	2	.....
Harrison	10	11	19	17	12	4	7	10	7	2	17	23	29	25	16
Hocking	38	74	178	97	71	12	12	30	48	17	92	129	137	181	105
Holmes	.....	.....	1	.....	.....	3	.....	2	.....	3	4	.....	3	.....	3
Jackson	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	.....	.....	.....
Jefferson	28	30	60	33	16	31	19	22	16	14	79	57	83	58	32
Knox	.....	.....	1	.....	1	11	12	8	1	5	44	53	24	1	13
Lake	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
Licking	6	37	38	16	16	34	35	26	18	9	164	169	144	92	68
Lorain	1	1	1	.....	.....	2	13	5	3	3	6	19	8	4	5
Madison	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	.....	.....
Medina	1	.....	.....	.....	4	4	5	8	7	11	14	23	28	29	28
Meigs	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
Monroe	43	70	100	51	36	42	24	31	35	21	98	102	137	93	60
Morgan	117	118	142	91	64	55	78	50	45	21	172	196	192	136	85
Muskingum	9	18	21	15	19	12	11	8	5	7	28	30	33	23	27
Noble	95	19	62	45	36	62	21	37	40	25	163	43	101	90	67
Perry	[b] 107	188	172	112	41	[b] 31	23	40	34	12	[b] 140	219	220	151	55
Richland	.....	.....	.....	.....	.....	1	4	8	16	10	3	21	31	33	32
Ross	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....
Summit	.....	.....	.....	.....	.....	.....	2	2	.....	.....	.....	3	2	.....	.....
Tuscarawas	.....	.....	.....	.....	.....	.....	2	1	.....	.....	.....	2	1	.....	.....
Vinton	4	1	.....	.....	6	2	1	.....	2	14	8	5	.....	6	41
Washington	215	206	370	221	240	98	94	151	104	111	324	303	533	333	360
Wayne	1	14	25	9	.....	2	12	11	15	31	6	47	47	61	126
	765	846	1,246	863	677	512	460	603	517	472	1,680	1,717	2,191	2,044	1,910

[a] Includes gas wells.

[b] Includes Athens County.

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Oil wells and dry holes drilled in central and southeastern Ohio in 1915.

County.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Ashland	.....	1	.....	.....	.....	1	.....	1	.....	4	.....	2	.....	2
Athens	3	.....	1	.....	.....	.....	1	.....	5	.....	2	.....	.....	.....
Belmont	1	1	1	.....	.....	.....	2	1	.....	1	1	1	3	2
Carroll	3	2	3	2	2	1	.....	2	2	1	1	.....	1	.....
Columbiana	6	1	3	1	5	4	1	1	.....	2	1	3	.....	2
Cuyahoga	1	10	1	7	2	12	1	13	1	4	.....	1	1	4
Fairfield	3	.....	.....	1	2	.....	.....	2	1	1	1	1	4	.....
Harrison	.....	.....	.....	.....	2	1	.....	.....	1	.....	2	.....	.....	.....
Hocking	6	3	8	.....	.....	.....	3	1	12	3	3	.....	4	2
Holmes	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Jefferson	.....	.....	.....	.....	2	1	3	.....	.....	1	.....	2	.....	2
Knox	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	2	.....	.....
Licking	.....	2	.....	1	.....	.....	.....	.....	.....	3	4	.....	.....	.....
Lorain	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Medina	.....	1	.....	1	.....	.....	.....	.....	.....	1	4	2	.....	3
Meigs	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Monroe	1	2	5	.....	3	2	3	3	3	4	3	1	5	.....
Morgan	5	.....	3	.....	6	1	11	3	.....	.....	4	2	7	4
Muskingum	.....	1	4	2	.....	.....	1	1	.....	1	.....	.....	1	.....
Noble	4	3	.....	1	5	2	4	2	4	1	1	.....	1	3
Perry	4	1	3	2	5	1	5	1	2	.....	4	1	2	1
Richland	.....	2	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Vinton	.....	.....	.....	.....	.....	1	.....	.....	1	.....	1	2	1	.....
Washington	18	12	7	8	15	12	23	6	18	8	17	7	17	8
Wayne	.....	.....	.....	2	.....	3	.....	3	.....	1	.....	4	.....	3
	55	42	39	29	49	42	58	40	50	36	50	31	47	36

County.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Ashland	.....	4	.....	4	.....	1	1	4	.....	3	1	27
Athens	1	1	1	.....	2	.....	.....	.....	.....	3	16	4
Belmont	.....	2	.....	1	2	1	.....	2	2	1	12	13
Carroll	3	.....	2	.....	3	.....	2	2	2	3	24	13
Columbiana	10	5	3	.....	3	1	2	1	3	2	37	23
Cuyahoga	1	4	.....	1	.....	1	2	5	3	6	13	68
Fairfield	.....	2	1	.....	.....	.....	.....	.....	.....	.....	12	7
Harrison	3	.....	.....	.....	.....	.....	3	1	1	.....	12	2
Hocking	3	2	9	.....	9	.....	4	3	10	3	71	17
Holmes	.....	.....	.....	1	.....	1	.....	1	.....	.....	.....	3
Jefferson	.....	2	2	2	4	1	2	2	3	1	16	14
Knox	.....	.....	.....	1	.....	.....	.....	.....	.....	2	1	5
Licking	2	1	3	.....	1	.....	4	2	2	.....	16	9
Lorain	.....	1	.....	1	.....	.....	.....	.....	.....	1	.....	3
Medina	.....	.....	.....	.....	.....	1	.....	2	.....	.....	4	11
Meigs	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1
Monroe	2	1	1	3	5	2	3	2	2	1	36	21
Morgan	2	4	4	2	5	4	7	1	10	.....	64	21
Muskingum	2	.....	1	.....	2	.....	6	2	2	.....	19	7
Noble	2	3	1	3	3	.....	4	5	7	2	36	25
Perry	3	3	2	.....	2	1	2	1	7	.....	41	12
Richland	.....	2	.....	1	.....	2	.....	2	.....	.....	.....	10
Vinton	.....	.....	1	1	.....	5	1	.....	1	5	6	14
Washington	17	10	23	4	20	11	36	13	29	12	240	111
Wayne	.....	5	.....	2	.....	3	.....	3	.....	2	.....	31
	51	52	54	27	61	35	79	54	84	48	677	472

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Wells completed in central and southeastern Ohio, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	61	45	66	105	55	36	31	45	52	42	138	90	140	197	198
February	59	49	76	86	39	32	17	51	51	29	121	83	165	165	158
March	57	48	95	76	49	41	28	36	29	42	121	97	151	121	166
April	61	65	94	112	58	33	26	44	54	40	114	113	148	193	152
May	65	79	123	100	50	38	33	46	50	36	129	127	184	190	128
June	71	89	110	88	50	50	32	49	48	31	151	158	172	182	134
July	57	86	104	83	47	56	50	50	57	36	149	177	174	224	119
August	61	81	131	70	51	53	49	61	56	52	133	163	227	180	161
September	66	71	122	27	54	36	65	49	28	27	144	196	200	142	139
October	67	94	120	42	61	48	51	57	37	35	162	203	224	151	158
November	171	65	105	32	79	45	41	49	35	54	172	156	200	148	218
December	69	74	100	42	84	44	37	66	20	48	146	154	206	151	184
	765	846	1,246	863	677	512	460	603	517	472	1,680	1,717	2,191	2,044	1,910

[a] Including gas wells.

Initial daily production of new wells completed in central and southeastern Ohio in 1915, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Ashland	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5	.....	5
Athens	4	1	.....	2	21	6	.....	1	3	4	.....	.....	42
Belmont	10	50	.....	10	.....	3	8	.....	.....	4	.....	7	92
Carroll	16	5	5	.....	8	3	10	9	11	40	11	10	128
Columbiana	11	13	9	2	.....	1	.....	24	7	9	10	7	93
Cuyahoga	25	25	15	10	50	.....	5	5	.....	.....	15	65	215
Fairfield	40	.....	25	.....	3	6	13	.....	10	.....	.....	.....	97
Harrison	.....	.....	4	.....	1	7	.....	6	.....	.....	15	2	35
Hocking	197	274	.....	205	455	160	135	85	565	345	485	910	3,816
Jefferson	.....	.....	12	15	.....	.....	.....	.....	7	10	4	5	53
Knox	.....	.....	.....	.....	.....	100	.....	.....	.....	.....	.....	.....	100
Licking	.....	.....	.....	.....	.....	170	.....	60	45	25	58	25	383
Medina	.....	.....	.....	.....	.....	35	.....	.....	.....	.....	.....	.....	35
Monroe	5	39	135	9	20	10	29	10	5	35	24	17	338
Morgan	13	11	18	57	.....	10	44	2	13	6	17	19	210
Muskingum	.....	129	.....	10	.....	.....	45	27	15	11	60	14	311
Noble	13	.....	20	10	10	1	2	5	1	8	11	12	93
Perry	160	65	172	130	70	140	110	35	15	25	4	95	1,021
Vinton	.....	.....	.....	.....	8	5	5	.....	3	.....	25	50	96
Washington	164	30	78	74	77	120	60	76	82	153	157	139	1,210
	658	642	493	534	723	777	466	345	782	675	901	1,377	8,373

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Total and average initial daily production of new wells in central and southeastern Ohio, 1911–1915, by counties, in barrels.

County.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Ashland	.....	.....	20	50	5	.....	.....	20.00	25.00	5.00
Athens	.....	8	39	14	42	.....	2.66	2.60	2.00	2.62
Belmont	.....	553	710	318	92	.....	61.44	33.81	21.20	7.67
Carroll	80	14	62	72	128	8.00	2.80	2.95	2.48	5.33
Columbiana	69	21	105	278	93	4.93	5.25	3.75	4.79	2.51
Coshocton	100	86	152	82	.....	14.29	9.55	10.13	6.31	.....
Cuyahoga	10	45	.....	78	215	10.00	11.25	.....	11.14	16.54
Fairfield	1,040	494	1,227	530	97	18.25	19.76	27.89	21.20	8.08
Guernsey	.....	.....	45	.....	.....	.....	.....	4.09	.....	.....
Harrison	35	59	86	57	35	3.50	5.36	4.53	3.35	2.92
Hocking	1,386	2,986	3,638	4,711	3,816	36.47	40.35	46.64	48.58	53.75
Holmes	.....	.....	2	.....	.....	.....	.....	2.00	.....	.....
Jefferson	91	135	218	101	53	3.25	4.50	3.63	3.06	3.31
Knox	.....	.....	10	.....	100	.....	.....	10.00	.....	100.00
Licking	143	734	857	330	383	2.38	19.84	22.55	20.62	23.94
Lorain	10	10	15	.....	.....	10.00	10.00	15.00	.....	.....
Medina	35	.....	.....	.....	35	35.00	.....	.....	.....	8.75
Monroe	393	784	912	348	338	9.14	11.20	9.12	6.82	9.39
Morgan	1,488	781	454	361	210	12.72	6.62	3.20	3.97	3.28
Muskingum	228	393	107	105	311	25.33	21.83	5.09	7.00	16.37
Noble	325	93	318	169	93	3.42	4.89	5.13	3.76	2.58
Perry	[a] 3,681	15,117	4,785	2,806	1,021	34.40	83.98	27.82	25.05	24.90
Ross	5	.....	.....	.....	.....	5.00	.....	.....	.....	.....
Vinton	77	5	.....	.....	96	19.25	5.00	.....	.....	16.00
Washington	1,702	1,290	1,676	1,307	1,210	7.91	6.26	4.53	5.91	5.04
Wayne	25	585	864	330	.....	25.00	41.78	34.56	36.67	.....
	10,923	24,193	16,302	12,047	8,373	14.28	28.60	13.08	13.96	12.37

[a] Includes Athens County.

Total initial daily production of new wells in central and southeastern Ohio, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911	882	973	666	687	1,222	709	577	772	895	916	1,526	1,098	10,923	910
1912	1,737	3,577	1,992	1,944	2,309	2,067	2,077	2,518	1,039	2,199	1,006	1,728	24,193	2,016
1913	871	1,116	1,241	1,023	1,328	1,282	1,507	1,609	1,559	2,159	1,784	823	16,302	1,359
1914	1,851	1,318	1,541	1,254	1,808	716	943	851	467	651	240	407	12,047	1,004
1915	658	642	493	534	723	777	466	345	782	675	901	1,377	8,373	698

In the following tables are shown the statistics of oil wells in the Lima district during the last five years:

Wells completed in the Lima district, 1911–1915.

County.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Allen	21	54	138	71	9	.....	2	5	4	.....	21	56	143	75	9
Auglaize	12	7	19	24	4	4	4	7	6	3	18	11	27	30	8
Erie	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	2
Hancock	104	101	172	120	36	2	7	20	19	4	113	116	193	144	40
Hardin	2	.....	.....	2	.....	.....	.....	.....	2	.....	2	.....	.....	4	.....
Henry	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Lucas	21	18	29	39	3	1	2	8	3	1	22	21	37	42	6
Mercer	9	11	40	15	3	2	1	5	2	1	12	12	45	17	4
Ottawa	14	7	24	17	4	3	2	3	.....	.....	18	9	29	17	5
Putnam	2	.....	2	3	.....	.....	.....	.....	.....	.....	2	.....	2	3	.....
Sandusky	56	53	104	145	27	2	8	5	6	1	58	62	109	152	28
Seneca	35	29	35	23	17	8	9	7	6	6	44	40	43	29	23
Shelby	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Van Wert	23	19	38	41	5	1	1	4	2	1	24	21	42	45	6
Wood	179	177	271	263	116	9	18	23	19	7	191	196	298	288	127
Wyandot	2	4	1	.....	.....	.....	.....	2	.....	1	2	4	3	2	3
Miscellaneous	.....	2	.....	.....	.....	.....	1	1	.....	.....	.....	3	1	.....	.....
	480	482	873	765	224	32	55	90	69	27	527	551	972	850	261

[a] Including gas wells.

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Oil wells and dry holes drilled in the Lima district in 1915.

County.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen														
Auglaize			1			1	1							2
Erie								1		1				
Hancock	2		2	1	1		3		3		5		1	1
Lucas														
Mercer				1										
Ottawa					1		1		1					
Sandusky	2		3		3		2		3	1	1		2	
Seneca	1	1	1		1		2				2		2	2
Van Wert												1		
Wood	4		12		6	1	9	1	8		5	1	7	1
Wyandot				1										
	9	1	19	3	12	2	18	2	15	2	13	2	12	6

County.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen					1		4		4		9	
Auglaize							2				4	3
Erie												2
Hancock	5	2	5		2		6		1		36	4
Lucas	1	1	1				1				3	1
Mercer	1		1				1				3	1
Ottawa									1		4	
Sandusky	2		1		3		2		3		27	1
Seneca			2		2	1	4			2	17	6
Van Wert							3		2		5	1
Wood	12	1	12		13	1	15		13	1	116	7
Wyandot												1
	21	4	22		21	2	38		24	3	224	27

Wells completed in the Lima district, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	40	15	48	84	9	3	1	4	5	1	45	18	53	91	10
February	42	17	39	74	19	4	1	3	6	3	48	20	43	82	24
March	38	22	57	65	12	1	4	8	3	2	40	28	65	70	15
April	38	31	41	63	18		3	10	11	2	40	34	52	74	20
May	39	43	70	94	15	4	5	8	10	2	44	50	78	104	18
June	41	44	73	75	13	5	5	6	14	2	48	49	80	89	16
July	39	43	98	75	12	4	5	6	4	6	42	48	107	80	21
August	42	46	102	71	21	3	7	16	4	4	46	53	119	76	25
September	48	54	83	66	22		10	13	5		50	66	96	72	22
October	41	43	88	39	21	2	5	8	6	2	44	48	96	49	24
November	42	62	86	25	38	4	7	4			47	71	90	26	39
December	30	62	88	34	24	2	2	4	1	3	33	66	93	37	27
	480	482	873	765	224	32	55	90	69	27	527	551	972	850	261

[a] Including gas wells.

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Initial daily production of new wells completed in the Lima district in 1915, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Allen	.....	.....	.....	.....	.....	.....	.....	.....	.....	20	50	50	120
Auglaize	.....	10	.....	2	.....	.....	.....	.....	.....	.....	13	.....	25
Hancock	30	35	5	35	35	36	10	37	30	15	139	15	422
Lucas	.....	.....	.....	.....	.....	.....	.....	8	8	.....	10	.....	26
Mercer	.....	.....	.....	.....	.....	.....	.....	8	20	.....	10	.....	38
Ottawa	.....	.....	10	15	1	.....	.....	.....	.....	.....	.....	20	46
Sandusky	8	11	16	7	7	1	4	10	5	13	10	14	106
Seneca	5	500	100	150	.....	120	25	.....	450	110	94	.....	1,554
Van Wert	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	35	23	58
Wood	25	289	47	123	125	130	102	210	187	434	305	124	2,101
	68	845	178	332	168	287	141	273	700	592	666	246	4,496

Total and average initial daily production of new wells in the Lima district, 1911–1915, by counties, in barrels.

County.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Allen	171	609	1,883	762	120	8.1	12.9	13.6	10.7	13.33
Auglaize	174	47	142	285	25	14.5	6.7	7.5	11.9	6.25
Hancock	1,546	1,379	2,924	1,543	422	14.9	13.7	17.0	12.9	11.72
Hardin	25	.....	.....	61	.....	12.5	.....	.....	30.5	.....
Henry	.....	.....	.....	3	.....	.....	.....	.....	3.0	.....
Lucas	412	172	373	792	26	19.6	9.5	12.9	20.3	8.67
Mercer	60	111	573	183	38	6.7	10.1	14.4	12.2	12.67
Ottawa	108	36	148	117	46	7.7	5.1	6.2	6.9	11.50
Putnam	12	.....	7	43	.....	6.0	.....	3.5	14.3	.....
Sandusky	312	266	625	764	106	5.6	5.0	6.0	5.3	3.93
Seneca	341	1,041	713	713	1,554	9.7	35.9	20.4	31.0	91.41
Shelby	.....	.....	.....	10	.....	.....	.....	.....	10.0	.....
Van Wert	369	272	379	530	58	16.0	14.3	10.0	12.7	11.60
Wood	2,836	3,153	3,404	3,523	2,101	15.8	17.8	12.6	13.4	18.11
Wyandot	15	37	10	.....	.....	7.5	9.3	10.0	.....	.....
Miscellaneous	.....	16	.....	.....	.....	.....	8.0	.....	.....	.....
	6,381	7,229	11,181	9,329	4,496	13.3	15.0	12.8	12.2	20.07

Total initial daily production of new wells in the Lima district, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911	508	599	323	483	460	559	498	630	470	793	465	593	6,381	532
1912	192	221	983	440	619	767	643	781	743	463	839	538	7,229	602
1913	709	439	599	632	871	1,206	1,243	1,414	898	923	1,222	1,025	11,181	932
1914	959	916	1,057	759	967	1,088	1,117	657	697	277	221	614	9,329	777
1915	68	845	178	332	168	287	141	273	700	592	666	246	4,496	375

LIMA-INDIANA OIL FIELD.

GENERAL STATEMENT.

The Lima-Indiana field embraces all areas of oil production in the northwestern part of Ohio and in Indiana. Petroleum in this field is derived from strata belonging to the Ordovician, Silurian, and Carboniferous systems, the principal source being porous dolomitic lenses in the "Trenton" limestone of the Ordovician system. In the detached pools of western Indiana production is derived from the "Corniferous" limestone, of the Devonian system, and from

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sandstone in the Chester group of the Mississippian series (lower Carboniferous). The occurrence of the oil is in terraces or other minor structures on the flanks of the Cincinnati uplift or simply in porous lenses in limestone strata of uninterrupted dip.

MARKETED PRODUCTION.

Petroleum marketed in the Lima-Indiana field in 1914 and 1915, in barrels.

Month.	1914			1915		
	Lima, Ohio.	Indiana.	Total.	Lima, Ohio.	Indiana.	Total.
January	341,162	109,891	451,053	271,437	82,390	353,827
February	229,310	97,045	326,355	274,450	85,690	360,140
March	343,414	120,508	463,922	311,095	76,939	388,034
April	338,745	126,670	465,415	313,775	82,683	396,458
May	329,256	128,493	457,749	283,022	75,922	358,944
June	231,060	129,855	460,915	295,378	78,934	374,312
July	337,431	121,122	458,553	291,978	72,189	364,167
August	319,529	109,939	429,468	275,442	66,452	341,894
September	312,202	110,299	422,501	276,998	62,010	339,008
October	314,526	105,969	420,495	278,632	66,332	344,964
November	275,469	88,272	363,741	261,197	58,447	319,644
December	254,983	87,393	342,376	260,429	67,770	328,199
	3,727,087	1,335,456	5,062,543	3,393,833	875,758	4,269,591

Petroleum marketed in the Lima-Indiana field since 1886.

Year.	Marketed production (barrels).	Percentage of total production.	Increase or decrease.		Value.	Yearly average price per barrel.
			Barrels.	Per cent.		
1886	1,137,869	4.06	.....	.....	$444,198	$0.390
1887	4,650,375	16.44	+3,512,506	+308.69	953,327	.205
1888	9,682,683	35.07	+5,032,308	+108.21	1,452,402	.150
1889	12,186,564	34.66	+2,503,881	+ 25.86	1,833,859	.150
1890	15,078,378	32.91	+2,891,814	+ 23.73	4,536,927	.301
1891	17,452,612	32.15	+2,374,234	+ 15.75	5,333,797	.306
1892	15,867,575	31.41	−1,585,037	− 9.08	5,814,629	.366
1893	15,982,097	33.00	+ 114,522	+ .75	7,497,597	.469
1894	17,296,510	35.05	+1,314,413	+ 8.22	8,306,025	.480
1895	20,236,741	38.26	+2,940,231	+ 17.00	14,184,256	.700
1896	25,255,870	41.43	+5,019,129	+ 24.80	16,678,028	.660
1897	22,805,033	37.71	−2,450,837	− 9.70	10,848,097	.476
1898	20,321,323	36.71	−2,483,710	− 10.89	12,458,904	.613
1899	20,225,356	35.44	− 95,967	− .47	18,082,723	.894
1900	21,758,750	34.20	+1,533,394	+ 7.58	21,367,287	.982
1901	21,933,379	31.61	+ 171,629	+ .80	18,734,438	.851
1902	23,358,626	26.31	+1,425,247	+ 6.50	20,810,694	.890
1903	21,080,261	23.97	+ 721,638	+ 3.09	27,825,466	1.155
1904	21,689,184	21.09	+ 608,920	+ 2.53	26,970,803	1.092
1905	22,294,171	16.55	−2,395,013	− 9.70	19,466,901	.873
1906	17,554,661	13.88	−4,739,510	− 21.26	15,927,707	.907
1907	13,121,094	7.90	−4,433,567	− 25.26	11,962,410	.912
1908	10,032,305	5.62	−3,088,789	− 23.54	10,065,768	1.003
1909	8,211,443	4.48	−1,820,862	− 18.15	7,449,107	.907
1910	7,253,861	3.46	− 957,582	− 11.66	5,750,104	.793
1911	6,231,164	2.83	−1,022,697	− 14.10	5,116,954	.821
1912	[a] 4,925,906	2.21	−1,305,258	− 20.95	4,794,784	.932
1913	4,773,138	1.93	− 152,768	− 3.10	6,588,068	1.380
1914	5,062,543	1.90	+ 289,405	+ 6.07	5,983,356	1.182
1915	4,269,591	1.52	− 792,952	− 15.66	4,114,228	.964
	437,729,070	12.10	.....	.....	321,352,844	.734

[a] Includes production of Michigan.

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Petroleum marketed in the Lima-Indiana field in 1914 and 1915, by districts.

District.	Marketed production (barrels).		Decrease.	
	1914	1915	Barrels.	Per cent.
North Lima	3,077,007	2,826,974	250,033	8.13
South Lima	650,080	566,859	83,221	12.80
Indiana	1,335,456	875,758	459,698	34.42
	5,062,543	4,269,591	792,952	15.66

Petroleum marketed, value, and average price per barrel in the Lima-Indiana field, 1906–1915.

Year.	North Lima, Ohio.			South Lima, Ohio.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1906	6,859,669	$6,479,607	$0.944	3,021,515	$2,678,034	$0.886
1907	6,399,917	6,016,238	.940	1,593,140	1,409,242	.885
1908	5,430,124	5,574,400	1.027	1,318,552	1,287,485	.977
1909	4,761,065	4,434,277	.931	1,154,292	1,017,220	.881
1910	4,131,060	3,431,618	.831	963,076	750,011	.779
1911	3,676,397	3,221,308	.876	859,478	666,811	.776
1912	[a] 3,237,926	3,237,849	1.000	717,971	670,960	.934
1913	3,144,968	4,403,858	1.400	672,075	904,984	1.346
1914	3,077,007	3,687,742	1.198	650,080	747,572	1.150
1915	2,826,974	2,767,825	.979	566,859	533,008	.940

Year.	Indiana.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1906	7,673,477	$6,770,066	$0.882	17,554,661	$15,927,707	$0.907
1907	5,128,037	4,536,930	.885	13,121,094	11,962,410	.912
1908	3,283,629	3,203,883	.976	10,032,305	10,065,768	1.003
1909	2,296,086	1,997,610	.870	8,211,443	7,449,107	.907
1910	2,159,725	1,568,475	.726	7,253,861	5,750,104	.793
1911	1,695,289	1,228,335	.725	6,231,164	5,116,954	.821
1912	970,009	885,975	.913	4,925,906	4,794,784	.932
1913	956,095	1,279,226	1.337	4,773,138	6,588,068	1.380
1914	1,335,456	1,548,042	1.159	5,062,543	5,983,356	1.182
1915	875,758	813,395	.929	4,269,591	4,114,228	.964

[a] Includes production of Michigan.

Petroleum marketed in the Lima-Indiana field, 1911–1915, in barrels.

Month.	1911	1912	1913	1914	1915
January	541,714	318,785	409,902	451,053	353,827
February	499,770	308,755	346,167	326,355	360,140
March	768,873	398,094	336,321	463,922	388,034
April	514,381	459,811	427,768	465,415	396,458
May	545,007	481,496	411,245	457,749	358,944
June	525,481	439,984	390,532	460,915	374,312
July	487,953	455,238	401,394	458,553	364,167
August	505,856	444,752	391,953	429,468	341,894
September	479,695	400,677	400,905	422,501	339,008
October	483,435	437,515	424,560	420,495	344,964
November	419,807	383,094	394,534	363,741	319,644
December	459,192	397,705	437,857	342,376	328,199
	6,231,164	4,925,906	4,773,138	5,062,543	4,269,591

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Average daily output of petroleum in the Lima-Indiana field, 1911–1915, in barrels.

Month.	1911	1912	1913	1914	1915
January	17,475	10,283	13,223	14,550	11,414
February	17,849	10,647	12,363	11,656	12,862
March	24,802	12,842	10,849	14,965	12,517
April	17,146	15,327	14,259	15,514	13,215
May	17,581	15,532	13,266	14,766	11,579
June	17,516	14,666	13,017	15,364	12,477
July	15,740	14,685	12,948	14,792	11,747
August	16,318	14,347	12,644	13,854	11,029
September	15,990	13,356	13,364	14,063	11,300
October	15,595	14,113	13,695	13,564	11,128
November	13,994	12,770	13,151	12,125	10,655
December	14,813	12,829	14,124	11,044	10,587
Average	17,072	13,459	13,077	13,870	11,698

PIPE-LINE RUNS.

Pipe-line runs in the Lima-Indiana oil field in 1914 and 1915, in barrels.

1914.

Month.	Buckeye pipe line.	Other Ohio lines.	Indiana pipe line.	Other Indiana lines.	Total.
January	240,830	100,332	49,141	60,750	451,053
February	161,001	68,309	34,748	62,297	326,355
March	236,771	106,643	41,493	79,015	463,922
April	232,468	106,277	49,558	77,112	465,415
May	231,764	97,492	45,612	82,881	457,749
June	228,892	102,168	44,667	85,188	460,915
July	230,815	106,616	45,176	75,946	458,553
August	215,483	104,046	40,109	69,830	429,468
September	214,212	97,990	40,010	70,289	422,501
October	213,851	100,675	41,345	64,624	420,495
November	185,997	89,472	31,271	57,001	363,741
December	175,184	79,799	30,510	56,883	342,376
	2,567,268	1,159,819	493,640	841,816	5,062,543

1915.

January	184,910	86,527	30,312	52,078	353,827
February	186,344	88,106	36,222	49,468	360,140
March	208,454	102,641	29,363	47,576	388,034
April	211,246	102,529	35,967	46,716	396,458
May	191,133	91,889	31,454	44,468	358,944
June	198,569	96,809	34,302	44,632	374,312
July	197,068	94,892	29,992	42,197	364,167
August	184,804	90,638	29,178	37,274	341,894
September	183,651	93,347	27,688	34,322	339,008
October	185,616	93,016	29,578	36,754	344,964
November	175,583	85,314	22,985	35,462	319,644
December	174,113	86,316	26,667	41,103	328,199
	2,281,809	1,112,024	363,708	512,050	4,269,591

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Pipe-line runs and deliveries of Lima-Indiana oil and stocks at end of each month in 1914 and 1915, in barrels.

Month.	1914			1915		
	Runs.	Deliveries.	Stocks.	Runs.	Deliveries.	Stocks.
Dec. 31, 1913	.....	.....	1,746,355	.....	.....	.....
January	451,053	365,581	1,831,827	353,827	303,383	1,699,050
February	326,355	276,382	1,881,800	360,140	228,015	1,831,184
March	463,922	626,835	1,718,887	388,084	236,367	1,982,851
April	465,415	424,473	1,759,829	396,458	217,643	2,161,666
May	457,749	502,862	1,714,716	358,944	161,423	2,359,187
June	460,915	357,174	1,818,457	374,312	160,494	2,573,005
July	458,553	443,323	1,833,687	364,167	118,497	2,818,675
August	429,468	378,259	1,884,896	341,894	275,393	2,885,176
September	422,501	387,762	1,919,635	339,008	278,506	2,945,678
October	420,495	450,280	1,889,850	344,964	269,445	3,021,197
November	363,741	490,933	1,762,658	319,644	329,580	3,011,261
December	342,376	456,419	1,648,615	328,199	420,812	2,918,648
	5,062,543	5,160,283	.....	4,269,591	2,999,558	.....

PRICES.

The following table shows the prices of Lima and Indiana oil in 1913–1915, and the dates on which changes in prices became effective.

Prices of Lima and Indiana petroleum in 1913–1915, per barrel.

1913				1914				1915				
Date.	North Lima.	South Lima and Indiana.	Princeton, Ind.	Date.	North Lima.	South Lima and Indiana.	Princeton, Ind.	Date.	Lima.		Indiana.	Princeton, Ind.
									North.	South.		
Jan. 1	$1.25	$1.20	$1.05	Jan. 1	$1.49	$1.44	$1.45	Jan. 1	$0.93	$0.88	$0.88	$0.89
Jan. 3	.....	.....	1.08	Apr. 18	1.44	1.39	1.40	Feb. 16	.88	.83	.83	.84
Jan. 6	1.28	1.23	.....	Apr. 25	1.39	1.34	1.35	Feb. 19	.....	.....	.78	.....
Jan. 27	1.31	1.26	1.11	Apr. 28	1.34	1.29	1.30	Aug. 12	.....	.....	.....	.89
Feb. 1	1.34	1.29	1.14	May 1	1.29	1.24	1.25	Aug. 20	.93	.88	.....	.94
Feb. 5	.....	.....	1.17	May 5	1.24	1.19	1.20	Aug. 23	.98	.93	.83	.99
Feb. 6	1.37	1.32	1.20	May 12	1.19	1.14	1.15	Aug. 30	.....	.98	.....	.....
Feb. 20	.....	.....	1.25	June 17	1.16	1.11	1.12	Sept. 4	1.03	1.03	.88	1.04
Apr. 16	1.39	1.34	1.30	Aug. 1	1.11	1.06	1.07	Sept. 15	1.08	1.08	.93	1.09
Nov. 5	1.44	1.39	1.35	Aug. 7	1.06	1.01	1.02	Sept. 27	.....	.....	.....	1.12
Nov. 22	1.49	1.44	.....	Sept. 15	1.01	.96	.97	Oct. 5	.....	.....	.....	1.17
Dec. 9	.....	.....	1.45	Sept. 23	.96	.91	.92	Oct. 23	1.13	1.13	.98	1.27
				Oct. 26	.93	.88	.89	Nov. 15	1.18	1.18	1.03	1.32
								Nov. 17	1.23	1.23	1.08	1.37
								Dec. 3	1.28	1.28	1.13	1.42
								Dec. 15	1.33	1.33	1.18	1.47

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Average monthly prices of Lima and Indiana petroleum in 1913, 1914, and 1915, per barrel.

Month.	1913			1914			1915			
	North Lima.	South Lima and Indiana.	Princeton, Ind.	North Lima.	South Lima and Indiana.	Princeton, Ind.	Lima.		Indiana.	Princeton, Ind.
							North.	South.		
January	$1.28	$1.23	$1.08	$1.49	$1.44	$1.45	$0.93	$0.88	$0.88	$0.89
February	1.36	1.31	1.21	1.49	1.44	1.45	.91	.86	.84	.87
March	1.37	1.32	1.25	1.49	1.44	1.45	.88	.83	.78	.84
April	1.38	1.33	1.28	1.45	1.40	1.41	.88	.83	.78	.84
May	1.39	1.34	1.30	1.21	1.16	1.17	.88	.83	.78	.84
June	1.39	1.34	1.30	1.18	1.13	1.14	.88	.83	.78	.84
July	1.39	1.34	1.30	1.16	1.11	1.12	.88	.83	.78	.84
August	1.39	1.34	1.30	1.07	1.02	1.03	.91	.86	.79	.90
September	1.39	1.34	1.30	1.02	.97	.98	1.05	1.03	.90	1.07
October	1.39	1.34	1.30	.95	.90	.91	1.09	1.06	.94	1.19
November	1.45	1.41	1.34	.93	.88	.89	1.18	1.18	1.03	1.32
December	1.49	1.44	1.42	.93	.88	.89	1.30	1.30	1.15	1.44
Average	1.390	1.340	1.282	1.19	1.15	1.16	.98	.94	.87	.99
Average of North Lima and South Lima and Indiana	1.365			1.17			0.93			

Highest, lowest, and average prices of Lima (Ohio) petroleum, 1906–1915, per barrel.

Year.	Highest.	Lowest.	Average.	Year.	Highest.	Lowest.	Average.
1906	[a] $0.98	[b] $0.85	$0.911	1911	[a] $0.84	[b] $0.77	$0.801
1907	[a] .94	[b] .85	.909	1912	[a] 1.25	[b] .79	.998
1908	[a] 1.04	[b] .89	1.001	1913	[a] 1.49	[b] 1.20	1.375
1909	[a] 1.04	[b] .79	.906	1914	[a] 1.49	[b] .88	1.17
1910	[a] .84	[b] .77	.804	1915	[a b] 1.33	[b] .88	.96

[a] North Lima. [b] South Lima.

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade journal sources and differ somewhat from those on pages 588 and 589, which are obtained from reports received directly from the oil producers:

Wells completed in the Lima-Indiana field, 1911–1915.

District.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Lima	480	482	873	765	224	32	55	90	69	27	527	551	972	850	261
Indiana	74	65	213	470	98	35	20	86	259	86	117	89	311	742	192
	554	547	1,086	1,235	322	67	75	176	328	113	644	640	1,283	1,592	453

[a] Including gas wells.

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Oil wells and dry holes drilled in the Lima-Indiana field in 1915.

District.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Lima	9	1	19	3	12	2	18	2	15	2	13	2	12	6
Indiana	5	9	10	2	11	3	11	7	7	7	6	8	8	10
	14	10	29	5	23	5	29	9	22	9	19	10	20	16

District.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Lima	21	4	22	.....	21	2	38	.....	24	3	224	27
Indiana	2	6	5	12	6	6	10	13	17	3	98	86
	23	10	27	12	27	8	48	13	41	6	322	113

Wells completed in the Lima-Indiana field, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	50	17	51	120	14	7	3	6	22	10	59	23	58	145	24
February	48	20	48	119	29	7	2	3	31	5	58	25	52	153	38
March	47	24	70	107	23	2	5	11	33	5	50	31	82	144	30
April	43	34	45	107	29	3	8	10	38	9	48	42	57	145	38
May	45	47	87	168	22	6	5	10	37	9	52	54	97	208	32
June	48	48	89	154	19	7	5	11	48	10	58	54	102	202	30
July	45	50	112	129	20	9	8	13	30	16	53	58	129	162	40
August	49	54	130	111	23	7	9	22	26	10	57	63	156	139	34
September	53	62	101	89	27	2	13	28	25	12	58	77	129	115	41
October	45	52	115	49	27	4	7	23	13	8	50	60	140	67	36
November	45	70	120	33	48	11	7	15	11	13	62	79	137	47	62
December	36	69	118	49	41	2	3	24	14	6	39	74	144	65	48
	554	547	1,066	1,235	322	67	75	176	328	113	644	640	1,283	1,592	453

[a] Including gas wells.

Initial daily production of new wells completed in the Lima-Indiana field in 1915, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Lima	68	845	178	332	168	287	141	273	700	592	666	246	4,496
Indiana	62	115	151	170	137	225	128	15	129	327	443	662	2,564
	130	960	329	502	305	512	269	288	829	919	1,109	908	7,060

Total and average initial daily production of new wells in the Lima-Indiana field, 1911–1915, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Lima	6,381	7,229	11,181	9,329	4,496	13.3	15.0	12.8	12.2	20.07
Indiana	1,096	1,083	7,393	8,436	2,564	14.8	16.7	34.7	18.0	26.16
	7,477	8,312	18,574	17,765	7,060	13.5	15.2	17.1	14.4	21.93

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Total initial daily production of new wells in the Lima-Indiana field, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911.....	650	652	452	556	526	636	605	785	545	878	517	675	7,477	623
1912.....	267	281	1,013	490	704	824	690	863	891	635	1,026	628	8,312	693
1913.....	774	710	926	855	1,426	1,673	1,627	1,851	1,654	2,389	2,652	2,037	18,574	1,548
1914.....	1,636	2,129	2,187	1,859	1,944	2,245	1,928	1,067	969	431	372	898	17,765	1,480
1915.....	130	960	329	502	305	512	269	288	829	919	1,109	908	7,060	588

Oil wells abandoned in the Lima-Indiana oil field from June, 1905, to December, 1915, by months.

Month.	1905	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	Total.
January.....	.....	54	45	75	149	61	62	59	17	7	50	579
February.....	.....	74	83	59	106	66	21	34	21	4	31	501
March.....	.....	27	49	129	237	221	114	28	13	30	86	934
April.....	.....	47	129	198	98	140	31	86	47	23	55	854
May.....	.....	100	194	358	204	157	233	83	37	74	88	1,528
June.....	28	82	143	207	347	146	118	122	101	52	63	1,409
July.....	53	50	111	191	157	176	141	75	17	82	34	1,087
August.....	54	147	170	228	322	126	122	102	71	100	34	1,476
September.....	19	87	157	195	267	294	79	117	127	64	33	1,439
October.....	158	139	181	144	201	80	137	66	142	59	18	1,325
November.....	53	139	177	155	172	100	160	158	38	176	63	1,391
December.....	66	117	62	220	156	128	41	80	40	29	59	998
Total, Indiana.....	431	1,063	1,501	2,159	2,418	1,695	1,259	1,010	671	700	614	13,521
Total, Lima.....	674	1,059	1,357	1,135	1,127	1,500	1,142	856	601	485	664	10,601
Total, Lima-Indiana	1,105	2,122	2,858	3,294	3,545	3,195	2,401	1,866	1,272	1,186	1,278	24,122

Oil wells abandoned in the Lima-Indiana oil field, June, 1905, to December 31, 1915, by counties.

Lima.		Indiana.	
County.	Number of wells.	County.	Number of wells.
Allen	2,202	Adams	866
Auglaize	858	Blackford	1,389
Darke	4	Delaware	1,330
Hancock	1,386	Gibson	5
Lucas	451	Grant	4,141
Mercer	351	Hamilton	9
Ottawa	166	Huntington	891
Putnam	20	Jay	554
Sandusky	807	Knox	12
Seneca	119	Madison	87
Shelby	10	Marion	15
Van Wert	636	Miami	49
Wood	3,261	Pike	3
Wyandot	330	Randolph	213
		Sullivan	1
		Wabash	16
		Wells	3,950
	10,601		13,521

INDIANA.

GENERAL STATEMENT.

The output of petroleum in Indiana in 1915, which decreased 34 per cent from the output in 1914 and 8 per cent from the output in 1913, was less than in any other year since 1892, when the oil industry of this State was in its infancy. The decrease in 1915 is accounted for in part by the fact that the output in 1914 was exceptionally high,

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but is due chiefly to the advanced state of exhaustion of the known areas of production and the absence in the oil market of an adequate incentive for wildcatting in search of new territory. The bulk of the production in 1915 came from the pools in Wabash Valley, in the southwestern part of the State, the old "Trenton" rock areas in the northeastern part contributing a proportion that shows a steady yearly decline. More and more the position of Indiana in the ranks of the oil-producing States has come to depend on the output of the Wabash Valley pools, and it is to the development of pools of the type found there that the State must look if it is to continue long as even a small factor in the petroleum industry.

DEVELOPMENT.

Field activity in Indiana in 1915 resulted in the completion of 192 wells, of which 98 produced oil, 8 were classed as gassers, and 86 were barren. The new oil wells averaged relatively high in initial flow, being credited with a combined output of 2,564 barrels, or 26 barrels per well the first day of productive life. The ratio of 5 to 11 expresses the relation of dry holes to total completions in 1915 and is less favorable than that of 5 to 14 maintained in 1914.

Northeastern Indiana.—In the "Trenton" rock division of the Indiana fields the abandonment of exhausted wells constituted more of a feature than the drilling of new wells. A total of 607 wells was abandoned in this area, whereas only 8 new wells were drilled and only 4 of these produced oil. The lack of activity in this historic area is not due to the fact that there are no undrilled locations within productive limits; it is accounted for rather by the almost total exhaustion of the natural gas that was once so abundant in this division and also by the depressed condition of the oil market that essentially prohibited the substitution of more expensive fuel for drilling and pumping the wells of low yield that the area is capable of providing.

Southwestern Indiana.—Field activity in the restricted pools of southwestern Indiana attained about one-third its normal proportions and was largely confined to "inside" development. There were 184 wells drilled in this division during the year, of which 94 produced oil, yielding a combined initial output of 2,543 barrels, an average of 27 barrels per well for the first day of productive life.

A development of interest in this division in 1915 was the opening of an oil pool of small areal extent by the Emery Petroleum Co. on the Sutton and Finney farms, about 3 miles west of Petersburg, in sec. 30, Madison Township, Pike County. Considerable drilling had been done in this locality prior to 1915 but without success, on account of the abundance of salt water encountered and the failure to find more than small quantities of oil. Considerable difficulty with salt water was experienced in the course of the operations in 1915, but at the end of the year the pool was credited with 5 active oil wells, one of which was reported to have yielded 60 barrels of oil the first 24 hours after completion.

The completion in July, as a 15-barrel oil well, of a wildcat test on the Kayhill farm in sec. 8, Barr Township, Daviess County, attracted considerable attention as the possible forerunner of a new pool several miles east of prior discoveries of oil in Washington Township, this county. No additional wells were, however, completed in this locality in 1915. About 8 miles southwest of this test a dry hole was completed in August, in sec. 20, Vealie Township.

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A thorough test of all prospective oil territory in southwestern Indiana is certain to be made in 1916 as a consequence of the high level reached by crude oil prices during the closing months of 1915 and the early months of 1916.

MARKETED PRODUCTION.

Petroleum marketed in Indiana, 1911–1915, in barrels.

Month.	1911	1912	1913	1914	1915
January	146,582	64,403	73,237	109,891	82,390
February	135,064	62,991	70,336	97,045	85,690
March	355,552	81,148	57,204	120,508	76,939
April	133,947	92,965	78,764	126,670	82,683
May	139,302	101,102	77,379	128,493	75,922
June	132,096	85,819	73,056	129,855	78,934
July	120,737	90,011	73,838	121,122	72,189
August	122,416	86,492	72,467	109,939	66,452
September	114,109	78,432	81,462	110,299	62,010
October	107,317	83,634	91,368	105,969	66,332
November	89,007	69,733	98,444	88,272	58,447
December	99,160	73,279	108,540	87,393	67,770
	1,695,289	970,009	956,095	1,335,456	875,758

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade journal sources and differ somewhat from those on page 589, which are obtained from reports received directly from the oil producers:

Wells completed in Indiana, 1911–1915.

County.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Adams	1	6	8	4	.....	1	.....	.....	.....	.....	2	6	8	4	.....
Blackford	2	2	9	1	.....	.....	2	2	.....	.....	2	4	11	3	.....
Clay	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
Daviess	.....	1	1	.....	1	2	.....	.....	.....	3	7	2	1	.....	4
Delaware	10	15	47	24	1	5	7	8	8	.....	15	22	55	32	2
Dubois	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....
Gibson	.....	.....	18	3	4	1	.....	1	.....	5	1	.....	19	3	9
Grant	.....	1	1	3	.....	.....	1	1	.....	1	.....	2	4	4	1
Harrison	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....
Jay	9	14	27	14	1	3	4	6	4	.....	13	20	33	21	2
Knox	1	1	.....	.....	1	6	4	1	6	5	7	5	2	6	6
Madison	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	3	.....	.....	.....	.....
Martin	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....
Miami	.....	.....	.....	.....	.....	.....	.....	1	2	.....	.....	.....	1	2	.....
Pike	27	5	11	6	9	11	1	5	8	12	40	6	20	14	22
Putnam	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
Randolph	4	4	8	4	1	.....	.....	3	1	.....	4	4	11	7	2
Shelby	.....	.....	.....	4	1	.....	.....	.....	.....	.....	.....	.....	.....	4	1
Sullivan	.....	2	75	400	66	.....	.....	52	219	52	.....	2	132	624	122
Vigo	.....	1	.....	3	13	.....	.....	.....	2	4	.....	1	.....	5	17
Wabash	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Warrick	.....	.....	.....	.....	.....	1	.....	.....	.....	2	1	.....	.....	.....	2
Wells	17	6	5	1	.....	.....	.....	1	.....	.....	17	6	6	1	.....
Miscellaneous	3	7	3	.....	.....	2	1	5	7	.....	5	9	8	7	.....
	74	65	213	470	98	35	20	86	259	86	117	89	311	742	192

[a] Including gas wells.

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Oil wells and dry holes drilled in Indiana in 1915.

County.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Clay														
Daviess										1			1	
Delaware			1											
Gibson		1	1										2	
Grant		1												
Jay														
Knox		1	1							2				
Pike					1							1	1	1
Putnam										1				
Randolph									1					
Shelby							1							
Sullivan	4	5	7	2	10	3	10	4	4	3	4	7	3	3
Vigo	1							2	2		2		1	1
Warrick		1						1						
	5	9	10	2	11	3	11	7	7	7	6	8	8	10

County.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Clay										1		1
Daviess		1						1			1	3
Delaware											1	
Gibson	1			1		2		1			4	5
Grant												1
Jay			1								1	
Knox		1						1			1	5
Pike			3	2	1	1	1	6	2	1	9	12
Putnam												1
Randolph											1	
Shelby											1	
Sullivan	1	4		8	4	3	8	4	11	1	66	52
Vigo			1	1	1		1		4		13	4
Warrick												2
	2	6	5	12	6	6	10	13	17	3	98	86

Wells completed in Indiana, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	10	2	3	36	5	4	2	2	17	9	14	5	5	54	14
February	6	3	9	45	10	3	1		25	2	10	5	9	71	14
March	9	2	13	42	11	1	1	3	30	3	10	3	17	74	15
April	5	3	4	44	11	3	5		27	7	8	8	5	71	18
May	6	4	17	74	7	2		2	27	7	8	4	19	104	14
June	7	4	16	79	6	2		5	34	8	10	5	22	113	14
July	6	7	14	54	8	5	3	7	26	10	11	10	22	82	19
August	7	8	28	40	2	4	2	6	22	6	11	10	37	63	9
September	5	8	18	23	5	2	3	15	20	12	8	11	33	43	19
October	4	9	27	10	6	2	2	15	7	6	6	12	44	18	12
November	3	8	34	8	10	7		11	11	13	15	8	47	21	23
December	6	7	30	15	17		1	20	13	3	6	8	51	28	21
	74	65	213	470	98	35	20	86	259	86	117	89	311	742	192

[a] Including gas wells.

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Initial daily production of new wells completed in Indiana in 1915, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Daviess	.....	.....	.....	.....	.....	.....	15	.....	.....	.....	.....	.....	15
Delaware	.....	5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
Gibson	.....	10	.....	.....	.....	.....	13	5	.....	.....	.....	.....	28
Jay	.....	.....	.....	.....	.....	.....	.....	.....	4	.....	.....	.....	4
Knox	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Pike	.....	.....	20	.....	.....	.....	30	.....	75	2	25	52	204
Randolph	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	2
Shelby	.....	.....	.....	10	.....	.....	.....	.....	.....	.....	.....	.....	10
Sullivan	47	99	131	160	45	115	50	10	.....	225	393	475	1,750
Vigo	15	.....	.....	.....	90	110	20	.....	50	100	25	135	545
	62	115	151	170	137	225	128	15	129	327	443	662	2,564

Total and average initial daily production of new wells in Indiana, 1911–1915, by counties in barrels.

County.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Adams	10	103	73	43	.....	10.0	17.2	9.1	10.8	.....
Blackford	5	7	46	3	.....	2.5	3.5	5.1	3.0	.....
Daviess	.....	10	10	.....	15	.....	10.0	10.0	.....	15.00
Delaware	325	425	1,765	545	5	32.5	28.3	37.6	22.7	5.00
Gibson	.....	.....	332	9	28	.....	.....	18.4	3.0	7.00
Grant	.....	5	5	27	.....	.....	5.0	5.0	9.0	.....
Harrison	.....	.....	.....	10	.....	.....	.....	.....	5.0	.....
Jay	90	204	423	167	4	10.0	14.6	15.7	11.9	4.00
Knox	5	3	.....	.....	1	5.0	3.0	.....	.....	1.00
Pike	439	150	202	136	204	16.3	30.0	18.4	22.7	22.67
Randolph	26	35	395	80	2	6.5	8.8	49.4	20.0	2.00
Shelby	.....	.....	.....	50	10	.....	.....	.....	12.5	10.00
Sullivan	.....	15	4,032	7,294	1,750	.....	7.5	53.8	18.2	26.51
Vigo	.....	30	.....	50	545	.....	30.0	.....	16.7	41.92
Wabash	.....	.....	.....	20	.....	.....	.....	.....	20.0	.....
Wells	181	31	50	2	.....	10.6	5.2	10.0	20.0	.....
Miscellaneous	15	65	60	.....	.....	5.0	9.3	20.0	.....	.....
	1,096	1,083	7,393	8,436	2,564	14.8	16.7	34.8	18.0	26.16

Total initial daily production of new wells in Indiana, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911	142	53	129	73	66	77	107	155	75	85	52	82	1,096	91
1912	75	60	30	50	85	57	47	82	148	172	187	90	1,083	90
1913	65	271	327	223	555	467	384	437	756	1,466	1,430	1,012	7,393	616
1914	677	1,213	1,130	1,100	977	1,257	811	410	272	154	151	284	8,436	703
1915	62	115	151	170	137	225	128	15	129	327	443	662	2,564	214

ILLINOIS OIL FIELD.

GENERAL STATEMENT.

The quantity of petroleum marketed in 1915 in Illinois was less by 2,878,054 barrels, or 13 per cent, than the corresponding output in 1914. This deficiency, which indicates an abnormally high rate of decline for the Illinois fields, was due primarily to the absence in the oil market of any incentive for active development in proved areas or for drilling in wildcat territory until too late in the year for the results to affect statistics of production.

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Owing in part to this decline and in part to increased output in Texas, Illinois, which has ranked third in quantity of output among the oil-producing States since 1907, was forced in 1915 into fourth place, for which Louisiana is certain to be a strong contender in 1916.

The price of petroleum of Illinois grade, which began its recession from the former high level of $1.45 a barrel on April 18, 1914, reached its lowest level of 84 cents a barrel on February 16, 1915. This level was maintained until August 13 when an upward movement began which advanced the price to $1.47 a barrel before the end of 1915 and to $1.82 a barrel before the end of March, 1916.

The inability of production to respond promptly to this evidence of increasing demand necessitated requisitions on the stocks of Illinois oil held by pipe-line companies, and, though these stocks had been increased to the extent of about 1,000,000 barrels during the early months of the year, they were depleted more than 2,000.000 barrels between July 1 and December 31.

DEVELOPMENT.

Field activity in Illinois in 1915 was less than in any year since 1905, when the petroleum industry of this State began to assume commercial importance, and was only about half as great as in 1914. A total of 757 wells were completed in 1915, as compared with 1,579 in 1914 and 1,721 in 1913. Included in the completions during 1915 were 539 oil wells, with an average yield of 26 barrels each the first day of productive life, 19 gas wells, and 199 dry holes. This activity included 22 counties in its scope but was restricted for the most part to areas of proved worth, as indicated by the fact that barren wells constitute only 16 per cent of the total completions in 1915 as contrasted with 25 per cent in 1914.

SOUTHEASTERN ILLINOIS.

Cumberland, Coles, Clark, Edgar, and Jasper counties.—In the shallow-sand fields of these counties, in which wells having as much as 20 barrels of initial yield can be completed at depths of less than 600 feet, the decrease in field activity was less apparent than elsewhere in the State. In 1915 there were 192 wells completed in this district, of which 149 yielded an average initial oil production of 19 barrels each, 4 yielded gas only, and 39 were barren. A restricted area designated as the McClintock pool, located about 4 miles southwest of Casey in secs. 6 and 1, Crooked Creek Township, Cumberland County, was fully developed in the early months of 1915 as a consequence of oil discoveries in this locality in 1914. This development inspired additional drilling toward the north in an unsuccessful effort to prove that the new pool represented a long-hoped-for extension of the old Siggins pool in Union Township.

In Clark County activity was centered in the southern part of Parker Township, where a number of good wells were completed. The feature well of this development was No. 4 on the Knecht farm in sec. 32, which was completed in June at a depth of 388 feet, and credited with an output of 438 barrels the first day of productive life.

In May three small oil wells were completed near the town of Kansas, in Kansas Township, Edgar County, in a locality where previous tests had been unsuccessful.

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Crawford and Lawrence counties.—In the deep-sand fields of Crawford and Lawrence counties, where the greater part of the production is derived from sands lying at depths of 1,600 to 2,200 feet below the surface, the influence of the depressed oil market on drilling activity was decidedly apparent.

Only 372 wells were completed in these two counties in 1915, as contrasted with 1,071 in 1914 and 1,332 in 1913. The combined initial output of oil resulting from this activity was 8,105 barrels—1,776 barrels, an average of 12 barrels each, being credited to 153 wells in Crawford County, and 6,329 barrels, an average of 49 barrels each, being credited to 128 wells in Lawrence County.

In Crawford County the area about Flat Rock supported the greatest activity which had for its object the development of small extensions of the Flat Rock district proved in 1914. An appreciable part of this activity consisted in deepening former gas wells, in secs. 2, 3, and 4, Honey Creek Township, from about 1,000 to 1,075 feet and converting them to oil producers in a productive sand, the presence of which was determined in 1914 by the Ohio Oil Co.

In Lawrence County most of the new work was confined to Dennison Township and consisted largely in drilling inside locations in the southeastward extension of the Dennison Township pool demonstrated in 1914 by the discovery of the Murphy pool in sec. 5, T. 2 N., R. 11 W., and the outlying St. Francisville pool, 3 miles farther south, in secs. 19 and 20 of the same township. No appreciable additions were made to the productive area in 1915.

Wabash County.—Six wells were completed in the Allendale pool in 1915, of which five furnished a combined initial output of 328 barrels. Early in December the completion, at a depth of 1,579 feet, of a wildcat well, reported good for 8 barrels of oil the first 24 hours, located 3 miles southwest of the Allendale pool and 2 miles northeast of the village of Friendsville aroused considerable speculation as to the possibility of a new pool comparable with Allendale on the west flank of the La Salle anticline.

SOUTH-CENTRAL ILLINOIS.

Clinton County.—The Carlyle pool, 3 miles northwest of Carlyle, had a normal decline in production. No new wells were reported in 1915. Late in December a test was started near Frogtown, in Breese Township, about 4 miles west of the Carlyle pool.

Marion County.—Six new wells, rated at an average of 45 barrels each the first day of productive life, constituted the year's developments in the Sandoval pool.

Macoupin County.—The Carlinville pool, developed for gas in 1909 and rejuvenated as an oil field in 1911, passed a featureless year, activity in this county being centered some 15 miles to the southeast in the successful development of a new pool near Staunton. The circumstances leading to the discovery of this pool and the results of the work there in 1915 are described by F. H. Kay[1] as follows:

In 1914 the Illinois Geological Survey described a dome northwest of Staunton, Macoupin County[2] The existence of the dome was determined by the position of coal No. 6 in coal test holes drilled by the Chicago & North Western Railway Co.

[1] Kay, F. H., Petroleum in Illinois in 1914 and 1915: Illinois State Geol. Survey Bull. 33, pp. 15–18, 1916.
[2] Blatchley, R. S., Oil and gas in Bond, Macoupin, and Montgomery counties: Illinois State Geol. Survey Bull. 28, 1914. Also Kay, F. H., Coal resources of District VII: Illinois Coal Mining Investigations Bull. 11, 1915.

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It was later described in greater detail by Wallace Lee,[1] of the United States Geological Survey, in cooperation with the Illinois Survey. Early in 1915 Miller Bros., of Staunton, drilled a well near the highest part of the dome in the southeast corner of the SW. ¼ SW. ¼ sec. 14, T. 7 N., R. 7 W. (Dorchester), and brought in a large production of gas from a sand at 441 feet. Prospecting was stimulated, and before the end of the year a number of wells were drilled in the area. In the N. ½ sec. 23 and the S. ½ sec. 14 seven gas wells were completed, the largest of which (Daniel Groves No. 1) is reported to have a capacity of 20,000,000 cubic feet per day.

One mile northwest of the principal gas area the Ohio Oil Co. drilled G. W. Groves No. 1 in the northeast corner of the SE. ¼ NW. ¼ sec. 15, T. 7 N., R. 7 W., and at 461 feet reached a sand that produced about 2,000,000 cubic feet of gas per day. At 480 feet a show of black oil was found, and at 565 a good show of green oil was developed. Salt water came in at the same time. About 1 mile southeast of the main gas wells the Miller Bros. completed a 5-barrel oil well at the center of sec. 24, T. 7 N., R. 7 W. The sand lies at 442 feet. In the SE. ¼ SW. ¼ sec. 24 Fleeger & Lamberton discovered gas at 427 feet, with a reported flow of about 700,000 cubic feet per day.

The large gas wells are located on the top of the dome, where the beds lie from 40 to 60 feet higher than in the surrounding area. * * *

The producing sands lie in the basal part of the "Coal Measures," the upper one occupying about the position of coal No. 2. No single sandstone can be traced throughout the area; in other words, the sands were probably deposited in channels whose streams eroded away the beds such as the coals normally in the bottom part of the "Coal Measures." Two such lenses are represented in the larger gas wells, the top of the first being from 195 to 215 feet below the top of coal No. 6, whereas in H. Woolridge No. 1, SW. ¼ SE. ¼ sec. 14, T. 7 N., R. 7 W., no sand was found at the upper horizon, but 255 feet below coal No. 6 a good flow of gas was tapped in a lower lens.

This lower sand corresponds in position with the sand from which oil is obtained in the Miller oil well at the center of sec. 24, T. 7 N., R. 7 W. Whether or not the sand is continuous between the two wells must be decided by the drill. It is probable that the sand 233 feet below the coal in the gas well, NW. ¼ NE. ¼ sec. 23, T. 7 N., R. 7 W., represents a lens intermediate between the two mentioned above. * * *

In his report on the Gillespie and Mount Olive quadrangles, Wallace Lee [2] calls attention to three productive lenses of sand in the Carlinville field, the upper one about 200 feet below coal No. 6, the second 20 or 25 feet lower, and the main horizon 15 to 25 feet below the second. In position, the Staunton sands agree in general with those at Carlinville, although it must be understood that laterally at any given horizon shale exists here and there in place of sand, and no sand is continuous.

During the last half of July and the first half of August activity was retarded by litigation between the oil and coal companies whose interests conflicted in this locality. A temporary injunction restraining the oil companies from drilling through coal beds known to underlie certain parts of the prospective oil and gas area was dissolved by a decree permitting the oil companies to proceed with developments subject to a limitation of three wells on each 40 acres and to a decision by the coal companies as to the location of the wells.

Montgomery County.—Three unsuccessful tests were completed in Montgomery County in 1915, one near Litchfield, one near Butler, and one southwest of Hillsboro.

Bond County.—Late in 1915 tests were commenced in Bond County in sec. 29, T. 6 N., R. 2 W. (Mulberry Grove), and in sec. 11, T. 4 N., R. 3 W. (Mills).

Miscellaneous tests.—In 1915 unsuccessful tests were drilled near Xenia, Clay County; Ava, Jackson County; Irishtown, Clinton County; Plumhill, Washington County; Steeleville, Randolph County; West Salem, Edwards County; Belleville, St. Clair County; and Equality, Gallatin County.

One wildcat test in southern Illinois was reported drilling at the end of 1915 in Saline County, near Eldorado.

[1] Lee, Wallace, Oil and gas in Gillespie and Mount Olive quadrangles: Illinois State Geol. Survey Bull. 31, p. 101, 1915.
[2] Op. cit.

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WESTERN ILLINOIS.

McDonough County.—The area of oil production in the Colmar district, discovered in March, 1914, near the center of Lamoine Township, supported a fair activity throughout 1915 as a consequence of the discovery in July of a second restricted pool of oil on the P. Hamm farm, about 2 miles southwest of the original Hoing pool. Subsequent activity about the boundaries of the new pool failed to disclose further extensions of the productive area into Hancock County on the west or into Schuyler County on the south.

Schuyler County.—Kay[1] summarizes the results of drilling in Schuyler County as follows:

During 1915 seven wells were drilled on domes and terraces in Schuyler County; 10 others were drilled without regard to structure or at least so far from favorable features that they can not be regarded as tests except as to the presence or absence of the sand. Of the seven wells drilled on domes and terraces, six found no sand at the Hoing horizon, a probability to which attention was called in Bulletin 31. Despite the absence of sand, the Indian Refining Co., in sec. 9, T. 2 N., R. 2 W. (Buena Vista), found a splendid show of oil in the "second lime," near the top of the Buena Vista dome. The only well located near the top of the Littleton dome—C. E. Hites & Co.—NE. ¼ NE. ¼ sec. 13, T. 3 N., R. 2 W. (Littleton)—found a good show of oil in the Hoing sand which contains salt water.

Hancock County.—Eight barren wells were added in 1915 to the 19 similar tests completed in Hancock County in 1914, subsequent to the drilling of a single oil well in sec. 24, St. Marys Township, in September of that year.

MISCELLANEOUS TESTS.

In 1915 unsuccessful wildcat wells were drilled near Lima and Golden, Adams County, and near Aledo, Mercer County, and tests were started in Pea Ridge and Missouri townships, Brown County.

In north-central Illinois a test drilled for oil near Haworth, McLean County, was unsuccessful.

MARKETED PRODUCTION.

Petroleum marketed in Illinois, 1889–1915, in barrels.

Year.	Marketed production.	Percentage of total production.	Increase or decrease.		Value.	Yearly average price per barrel.
			Barrels.	Per cent.		
1889	1,460				$4,906	$3.360
1890	900		− 560	− 38.36	3,000	3.333
1891	675		− 225	− 25.00	2,363	3.500
1892	521		− 154	− 22.81	1,823	3.500
1893	400		− 121	− 23.22	1,400	3.500
1894	300		− 100	− 25.00	1,800	6.000
1895	200		− 100	− 33.33	1,200	6.000
1896	250		+ 50	+ 25.00	1,250	5.000
1897	500		+ 250	+ 100.00	2,000	4.000
1898	360		− 140	− 28.00	1,800	5.000
1899	360				1,800	5.000
1900	200		− 160	− 44.44	1,000	5.000
1901	250		+ 50	+ 25.00	1,250	5.000
1902	200		− 50	− 20.00	1,000	5.000
1903			− 200	− 100.00		
1904						
1905	181,084	0.13	+ 181,084		116,561	.644
1906	4,397,050	3.47	+ 4,215,966	+2,328.18	3,274,818	.745
1907	24,281,973	14.62	+19,884,923	+ 452.23	16,432,947	.677
1908	33,686,238	18.87	+ 9,404,265	+ 38.73	22,649,561	.672
1909	30,898,339	16.87	− 2,787,899	− 8.28	19,788,864	.640
1910	33,143,362	15.82	+ 2,244,923	+ 7.27	19,669,383	.593
1911	31,317,038	14.21	− 1,826,224	− 5.51	19,734,339	.639
1912	28,601,308	12.83	− 2,715,730	− 8.67	24,332,605	.851
1913	23,893,899	9.62	− 4,707,409	− 16.45	30,971,910	1.296
1914	21,919,749	8.25	− 1,974,150	− 8.26	25,426,179	1.160
1915	19,041,695	6.77	− 2,878,054	− 13.13	18,655,850	.980
	251,368,311	6.95			201,079,609	.800

[1] Op. cit.

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Petroleum marketed in Illinois, 1911–1915, in barrels.

Month.	1911	1912	1913	1914	1915
January	2,578,579	2,241,867	2,149,264	1,935,492	1,614,026
February	2,373,229	2,262,440	1,859,412	1,570,790	1,542,383
March	2,790,515	2,369,428	2,008,245	1,969,915	1,761,099
April	2,560,963	2,351,693	2,015,058	1,833,099	1,643,479
May	2,731,965	2,535,039	2,117,425	1,970,688	1,638,733
June	2,634,521	2,503,038	2,003,278	1,932,303	1,603,733
July	2,740,654	2,698,582	2,075,444	1,907,521	1,636,932
August	2,770,946	2,519,651	2,001,228	1,844,983	1,593,436
September	2,615,120	2,366,712	1,942,052	1,817,437	1,535,040
October	2,638,927	2,424,472	1,982,002	1,813,364	1,533,972
November	2,400,670	2,174,856	1,819,116	1,678,783	1,452,285
December	2,480,949	2,153,530	1,921,375	1,645,374	1,486,577
	31,317,038	28,601,308	23,893,899	21,919,749	19,041,695

Average daily output of petroleum in Illinois, 1911–1915, in barrels.

Month.	1911	1912	1913	1914	1915
January	83,180	72,318	69,331	62,435	52,065
February	84,758	78,015	66,407	56,100	55,085
March	90,017	76,433	64,782	63,546	56,810
April	85,365	78,390	67,169	61,103	54,783
May	88,128	81,775	68,304	63,570	52,862
June	87,817	83,435	66,776	64,410	53,458
July	88,408	87,051	66,950	61,533	52,804
August	89,385	81,279	64,556	59,516	51,401
September	87,171	78,890	64,735	60,581	51,168
October	85,127	78,209	63,936	58,496	49,483
November	80,022	72,495	60,637	55,959	48,410
December	80,031	69,469	61,980	53,076	47,954
Average	85,800	78,146	65,463	60,054	52,169

PIPE-LINE RUNS, DELIVERIES, AND STOCKS.

Pipe-line runs and deliveries to trade of petroleum from Illinois and stocks at end of each month in 1914 and 1915, in barrels.

Month.	1914			1915		
	Runs.	Deliveries.	Stocks.[a]	Runs.	Deliveries.	Stocks.
Dec. 31, 1913			8,243,421			
January	1,935,492	1,999,562	8,179,351	1,614,026	2,880,490	12,297,279
February	1,570,790	1,630,031	8,120,110	1,542,383	1,452,630	12,387,032
March	1,969,915	1,751,213	8,338,812	1,761,099	1,596,789	12,551,342
April	1,833,099	1,287,533	8,884,378	1,643,479	1,394,941	12,799,880
May	1,970,688	1,106,610	9,748,456	1,638,733	1,492,268	12,946,345
June	1,932,303	1,336,937	10,343,822	1,603,733	1,286,497	13,263,581
July	1,907,521	1,336,571	10,914,772	1,636,932	2,171,851	12,728,662
August	1,844,983	844,178	11,915,577	1,593,436	1,903,128	12,418,970
September	1,817,437	1,157,088	12,575,926	1,535,040	1,754,855	12,199,155
October	1,813,364	1,330,773	13,058,517	1,533,972	1,632,584	12,100,543
November	1,678,783	1,549,704	13,187,596	1,452,285	1,791,176	11,761,652
December	1,645,374	1,269,227	13,563,743	1,486,577	1,920,215	11,328,014
	21,919,749	16,599,427		19,041,695	21,277,424	

[a] Includes a small quantity of Indiana oil of Illinois grade.

The following tables show the runs, deliveries, and stocks of the Ohio Oil Co. during the years 1911–1914 and of the Illinois Pipe Line Co. in 1915. In December, 1914, the latter company took over the pipe-line business of the former company.

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Pipe-line runs, deliveries, and stocks of the Ohio Oil Co. and the Illinois Pipe Line Co. in Illinois, 1911–1915, in barrels.

Pipe-line runs.

Month.	1911	1912	1913	1914	1915
January	2,137,674	1,853,266	1,591,944	1,425,574	1,183,446
February	1,968,429	1,853,379	1,348,292	1,148,926	1,119,973
March	2,349,208	1,949,945	1,457,711	1,469,331	1,268,446
April	2,138,500	1,916,071	1,456,551	1,328,430	1,159,393
May	2,264,925	2,084,743	1,551,323	1,434,303	1,155,255
June	2,177,280	2,083,087	1,471,437	1,407,706	1,134,519
July	2,265,374	2,230,164	1,531,800	1,398,849	1,144,094
August	2,312,973	1,996,824	1,483,801	1,371,731	1,112,979
September	2,154,693	1,871,325	1,437,974	1,345,016	1,077,996
October	2,172,457	1,901,119	1,473,679	1,350,167	1,078,114
November	1,977,073	1,668,306	1,360,159	1,246,292	1,013,783
December	2,068,894	1,594,700	1,420,484	1,222,575	1,016,719
	25,987,480	23,002,929	17,585,155	16,148,900	13,464,717

Deliveries.[a]

January	933,861	1,350,621	1,201,633	936,867	31,910
February	838,566	1,387,078	1,042,834	1,027,023	26,809
March	1,218,111	1,532,428	1,172,522	749,703	24,703
April	1,022,936	1,420,013	1,139,433	525,769	23,681
May	1,132,331	1,301,727	1,226,625	819,105	30,611
June	1,174,211	1,302,537	1,161,667	752,134	16,192
July	1,231,534	1,327,329	1,171,492	803,558	15,907
August	1,206,244	1,306,563	794,844	474,569	21,252
September	1,252,988	1,359,968	1,039,267	594,960	36,565
October	1,352,605	1,401,807	1,065,320	630,028	29,737
November	1,304,663	1,230,357	810,907	256,567	16,551
December	1,454,394	1,206,516	1,204,375	15,090	14,319
	14,122,344	16,126,944	13,030,919	7,585,373	288,227

Stocks.[b]

January	26,252,274	18,393,303	11,118,521	5,508,791	3,351,079
February	25,643,012	17,706,835	10,344,393	5,188,339	3,689,625
March	24,005,215	17,279,112	9,935,612	5,627,743	4,460,698
April	24,013,861	17,001,576	9,446,550	6,500,409	5,177,985
May	24,138,187	16,636,329	8,941,584	7,284,952	5,625,562
June	23,195,749	16,235,353	8,054,011	8,035,036	5,763,894
July	22,714,129	15,689,994	7,548,743	8,682,851	4,990,447
August	22,265,928	14,682,823	6,876,978	9,683,090	5,165,511
September	21,904,719	13,949,064	6,416,698	10,473,407	5,083,656
October	21,359,482	13,039,507	5,748,180	11,033,448	4,979,712
November	20,211,934	12,307,725	5,829,018	11,183,664	4,799,585
December	19,131,678	11,591,427	5,551,356	11,390,608	4,611,579

[a] These deliveries are to trade only. Deliveries to other pipe lines are also made.
[b] Stocks include some Indiana petroleum of Illinois grade.

RAILROAD SHIPMENTS.

The following table shows the quantity of petroleum shipped by railroad from the Illinois oil field, 1911–1915, by months. The shipments were made by the Vandalia Railroad Co., the Baltimore & Ohio Southwestern Railroad Co., the Illinois Southern Railway Co., the Illinois Central Railroad Co., and the Cleveland, Cincinnati, Chicago & St. Louis Railway from Lawrenceville, Flat Rock, Sparta, Stoy, Bridgeport, Robinson, Sandoval, and Casey stations.

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Petroleum shipped by railroad in tank cars from Illinois oil field, 1911–1915, in barrels.

Month.	1911 a	1912 a	1913 a	1914 a	1915 a
January	228,404	232,522	192,735	189,689	114,905
February	224,856	172,106	167,632	129,220	132,246
March	254,927	216,156	176,028	185,210	156,241
April	347,530	211,809	135,341	195,535	172,324
May	333,324	232,043	226,364	215,962	163,198
June	329,621	214,860	224,614	236,792	145,400
July	311,681	211,025	272,536	204,147	143,101
August	297,784	281,991	264,424	158,930	162,903
September	238,917	210,974	271,709	152,805	139,365
October	292,004	249,263	299,451	152,237	145,064
November	263,627	222,866	291,287	143,853	132,608
December	285,082	219,034	298,227	141,291	118,432
	3,407,757	2,674,649	2,820,348	2,105,671	1,725,787

a Calculations made according to the specific gravity of the oil, ranging from 296.476 to 321.17 pounds to the barrel.

PRICES.

In the following table are shown the dates of change and the changes in prices at wells of the different grades of petroleum produced in Illinois during the years 1913–1915:

Prices per barrel of Illinois petroleum in 1913–1915.

1913			1914		1915		
Date.	Above 30° B.	Below 30° B.	Date.	All grades.	Date.	Illinois.	Plymouth.
Jan. 1	$1.08	$1.05	Jan. 1	$1.45	Jan. 1	$0.89	.....
Jan. 3	1.08	.....	Apr. 18	1.40	Feb. 16	.84	.....
Jan. 27	1.11	.....	Apr. 25	1.35	Aug. 13	.89	$0.58
Feb. 2	1.14	.....	Apr. 28	1.30	Aug. 20	.94	.....
Feb. 5	1.17	.....	May 1	1.25	Aug. 23	.99	.....
Feb. 6	1.20	.....	May 5	1.20	Sept. 4	1.04	.....
Feb. 20	1.25	.....	May 12	1.15	Sept. 10	.....	.78
Apr. 16	1.30	.....	June 17	1.12	Sept. 13	.....	.83
Nov. 5	1.35	.....	Aug. 1	1.07	Sept. 15	1.09	.....
Nov. 19	1.40	.....	Aug. 7	1.02	Sept. 27	1.12	.93
Nov. 22	1.45	.....	Sept. 14	.97	Oct. 5	1.17	.....
			Sept. 23	.92	Oct. 23	1.27	.....
			Oct. 26	.89	Nov. 15	1.32	1.03
					Nov. 17	1.37	1.13
					Dec. 3	1.42	.....
					Dec. 14	.....	1.23
					Dec. 15	1.47	1.33

Average monthly prices per barrel of Illinois petroleum, 1911–1915.

Month.	1911		1912		1913	1914	1915	
	Above 30° B.	Below 30° B.	Above 30° B.	Below 30° B.			Illinois.	Plymouth.
January	$0.60	$0.52	$0.72	$0.62	$1.09	$1.45	$0.89	.....
February	.60	.52	.78	.68	1.21	1.45	.87	.....
March	.60	.52	.81	.71	1.25	1.45	.84	.....
April	.60	.52	.81	.71	1.28	1.41	.84	.....
May	.63	.55	.84	.74	1.30	1.17	.84	.....
June	.64	.55	.85	.76	1.30	1.14	.84	.....
July	.65	.55	.85	.80	1.30	1.12	.84	.....
August	.65	.55	.87	.82	1.30	1.03	.90	$0.58
September	.66	.56	.87	.83	1.30	.98	1.07	.76
October	.67	.57	.87	.84	1.30	.91	1.19	.93
November	.67	.57	.93	.90	1.38	.89	1.32	1.03
December	.67	.57	1.04	1.02	1.45	.89	1.44	1.24
Average	.637	.546	.853	.786	1.288	1.16	.99	.91

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SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade journal sources and differ somewhat from those on page 589, which are obtained from reports received directly from the oil producers:

Wells completed in Illinois, 1911–1915.

County.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Adams										2					2
Bond						9			2		10			2	
Champaign										2					2
Clark	45	50	169	157	107	25	12	35	62	33	72	62	208	221	141
Clinton	123	35	14	2		49	13	5	2	2	172	48	19	4	2
Coles	2	1	3	16	2		5	3	5	1	2	6	6	21	3
Crawford	369	310	540	542	153	93	96	110	136	54	481	414	669	706	215
Cumberland	6	42	49	22	37	7	8	11	2	4	13	50	61	24	44
Edgar					3	1				1	1				4
Edwards										1					1
Hancock				1					19	8				20	8
Jackson		1					4	2		1		6	2		1
Jasper	3		2	3		2	1		2		5	1	2	5	
Lawrence	466	495	538	294	128	38	77	69	69	28	523	586	663	365	157
McDonough				138	97				36	33				174	130
Macoupin	2	1	3	3	1			6	2	3	2	1	9	5	10
Madison						1	4		1	1	1	4		1	1
Marion	44	22	21	6	6	11	4	1	1		55	26	22	7	6
Montgomery										3					3
Randolph							1			1		1			1
St. Clair										2					2
Saline								2	1				2	1	
Schuyler										17					17
Wabash		22	24	7	5		20	24	5	1		42	48	12	6
Washington										1					1
Miscellaneous	1	1				27	12	10	11		28	13	10	11	
	1,061	980	1,363	1,191	539	263	257	278	356	199	1,365	1,260	1,721	1,579	757

[a] Including gas wells.

Oil wells and dry holes drilled in Illinois in 1915.

County.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Adams				1				1						
Champaign				2										
Clark	6	3	4	1	2	1	10	1	9	3	6	6	13	3
Clinton		1				1								
Coles		1					1							
Crawford	11	3	7	1	13	5	8	1	6	6	11	5	14	8
Cumberland	1	1	2		2		3		1	1	6		3	
Edgar		1							3					
Edwards								1						
Hancock								1				1		1
Jackson		1												
Lawrence	13	3	6	3	18	5	15	1	9	4	12	2	12	1
McDonough			3	1	4		6	2	4	3	1	2	3	2
Macoupin														
Madison														
Marion					1				1				1	
Montgomery				1										
Randolph														
St. Clair														
Schuyler				2				2		1				1
Wabash													1	
Washington				1										
	31	14	22	13	40	12	43	10	33	18	36	16	47	16

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Oil wells and dry holes drilled in Illinois in 1914—Continued.

County.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Adams												2
Champaign												2
Clark	14	2	9	4	13	3	10	5	11	1	107	33
Clinton												2
Coles					1						2	1
Crawford	12	1	10	2	21	3	18	12	22	7	153	54
Cumberland	7	1	4		3	1			5		37	4
Edgar											3	1
Edwards												1
Hancock				2		2		1				8
Jackson												1
Lawrence	9	3	4	2	7	1	9		14	3	128	28
McDonough	8	6	21	5	11	6	19	4	17	2	97	33
Macoupin		3					1				1	3
Madison		1										1
Marion			1				1		1		6	
Montgomery		1				1						3
Randolph										1		1
St. Clair						2						2
Schuyler				1				3		7		17
Wabash	1	1							3		5	1
Washington												1
	51	19	49	16	56	19	58	25	73	21	539	199

Wells completed in Illinois, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	83	74	106	126	31	16	7	23	15	14	105	81	131	148	47
February	65	53	83	103	22	16	15	22	28	13	89	71	107	135	37
March	56	44	71	116	40	10	8	12	18	12	70	54	89	136	53
April	66	54	92	148	43	13	17	13	41	10	81	74	105	191	54
May	85	66	137	116	33	31	21	21	35	18	117	91	159	154	52
June	105	96	112	123	36	37	24	35	52	16	147	122	153	180	54
July	97	77	139	98	47	24	44	28	37	16	127	123	170	138	64
August	119	95	116	98	51	25	30	38	39	19	150	126	156	140	71
September	101	88	145	111	49	34	13	16	28	16	135	104	163	139	66
October	91	124	151	69	56	16	21	31	27	19	107	146	181	98	79
November	104	107	115	48	58	23	31	24	14	25	129	139	143	63	84
December	89	102	96	35	73	18	26	15	22	21	108	129	164	57	96
	1,061	980	1,363	1,191	539	263	257	278	356	199	1,365	1,260	1,721	1,579	757

[a] Including gas wells.

Initial daily production of new wells completed in Illinois in 1915 in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Clark	27	13	20	123	220	485	103	138	188	287	275	135	2,014
Coles				15						20			35
Crawford	78	57	155	66	55	115	253	190	115	256	252	184	1,776
Cumberland	10	80	10	115	85	120	55	110	75	95		55	810
Edgar					6								6
Lawrence	860	450	1,228	845	467	484	515	289	76	310	325	480	6,329
McDonough		40	40	90	70	15	300	540	702	295	254	246	2,592
Macoupin											5		5
Marion			25		50		40		80		40	35	270
Wabash							100	100				128	328
	975	640	1,478	1,254	953	1,219	1,366	1,367	1,236	1,263	1,151	1,263	14,165

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Total and average initial daily production of new wells in Illinois, 1911–1915, in barrels.

County.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Clark	771	1,178	2,610	1,590	2,014	17.1	23.6	15.4	10.1	18.82
Clinton	11,681	1,127	134	20	.....	95.0	32.2	9.6	10.0	.....
Coles	10	5	75	172	35	5.0	5.0	25.0	10.7	17.50
Crawford	9,802	7,175	9,990	8,613	1,776	26.6	23.1	18.5	15.9	11.61
Cumberland	100	800	595	127	810	16.7	19.0	12.1	5.8	21.89
Edgar	.....	.....	.....	.....	6	.....	.....	.....	.....	2.00
Hancock	.....	.....	.....	45	.....	.....	.....	.....	45.0	.....
Jackson	.....	3	.....	.....	.....	.....	3.0	.....	.....	.....
Jasper	20	.....	30	28	.....	6.7	.....	15.0	9.3	.....
Lawrence	40,432	51,975	32,316	24,324	6,329	86.8	105.0	60.1	82.7	49.45
McDonough	.....	.....	.....	3,919	2,592	.....	.....	.....	28.4	26.72
Macoupin	7	3	165	15	5	3.5	3.0	55.0	5.0	5.00
Marion	4,025	610	492	70	270	91.5	27.7	23.4	11.6	45.00
Wabash	.....	2,235	998	345	328	.....	101.6	41.6	49.3	65.60
Miscellaneous	3	575	.....	.....	.....	3.0	575.0	.....	.....	.....
	66,851	65,686	47,405	39,268	14,165	63.0	67.0	34.8	33.0	26.28

Total initial daily production of new wells in Illinois, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911	5,677	3,512	3,909	5,587	5,132	5,850	9,058	7,535	6,551	4,782	5,826	3,432	66,851	5,571
1912	3,894	4,367	2,323	3,768	4,013	10,761	6,879	6,114	4,679	7,367	7,104	4,508	65,686	5,474
1913	4,000	3,886	2,337	3,702	4,170	3,718	4,637	3,581	4,662	4,643	3,641	4,428	47,405	3,950
1914	2,925	3,415	2,443	4,838	5,552	6,542	3,801	2,792	2,925	1,517	1,156	1,362	39,268	3,272
1915	975	640	1,478	1,254	953	1,219	1,366	1,367	1,236	1,263	1,151	1,263	14,165	1,180

MID-CONTINENT OIL FIELD.

GENERAL STATEMENT.

For commercial purposes it is customary to group under the title "Mid-Continent field" the areas of oil production in Kansas, Oklahoma, northern and central Texas, and northern Louisiana. In Kansas, Oklahoma, and northern Texas petroleum is derived mainly from sandstone layers included in formations of the Pennsylvanian series (upper Carboniferous). In southern Oklahoma sandstone layers in the "Red Beds" of the Permian series (latest Carboniferous) form the reservoirs of oil in the Healdton district. In northern Louisiana and central Texas the oil is found in sandstones or other porous rocks belonging to the Cretaceous and Tertiary systems. The occurrence of oil throughout the Mid-Continent field is in anticlines, domes, half-domes, and terraces on the flanks of major uplifts, such as the Ozark, Wichita, Arbuckle, and Sabine.

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MARKETED PRODUCTION.

Petroleum marketed in the Mid-Continent field in 1914 and 1915, in barrels.

1914.

Month.	Kansas.	Oklahoma.	Northern Texas.	Northern Louisiana.	Total.
January	260,343	5,895,182	887,537	997,931	8,040,993
February	250,421	5,317,883	811,785	866,232	7,246,321
March	291,631	6,845,126	894,852	1,195,105	9,226,714
April	262,733	6,541,862	850,359	938,306	8,593,260
May	280,922	7,109,701	836,565	934,734	9,161,922
June	284,835	6,843,686	792,658	1,160,559	9,081,738
July	292,972	6,585,127	775,123	1,219,786	8,873,008
August	234,845	4,794,055	775,112	1,034,014	6,838,026
September	238,908	4,352,149	733,115	950,552	6,274,724
October	238,510	6,037,018	729,568	896,355	7,901,451
November	230,848	6,455,123	692,601	815,077	8,193,649
December	236,617	6,854,812	672,347	799,818	8,563,594
	3,103,585	73,631,724	9,451,622	11,808,469	97,995,400

1915.

January	245,606	6,356,810	637,798	816,369	8,056,578
February	207,411	6,553,703	574,546	902,532	8,238,192
March	226,183	7,428,985	623,146	1,069,387	9,347,651
April	209,173	11,250,823	677,655	1,168,191	13,305,842
May	211,159	7,762,963	714,495	1,271,150	9,959,767
June	217,638	8,363,142	674,941	1,240,860	10,496,781
July	239,216	9,113,460	644,076	1,505,859	11,502,611
August	247,029	7,966,760	621,330	1,653,871	10,488,990
September	252,748	7,874,149	584,039	1,592,323	10,303,259
October	259,494	7,843,458	583,498	1,346,369	10,032,814
November	262,955	7,923,886	562,467	1,268,839	10,018,127
December	244,675	9,477,174	577,122	1,246,284	11,545,255
	2,823,487	97,915,243	7,475,103	15,082,034	123,295,867
Increase or decrease, 1915:					
Barrels	−280,098	+24,283,519	−1,976,519	+3,273,565	+25,300,467
Per cent	− 9.02	+ 32.98	− 20.91	+ 27.72	+ 25.82

Petroleum marketed in the Mid-Continent field, 1889–1915.

Year.	Marketed production (barrels).	Percentage of total production.	Increase or decrease.		Value.	Yearly average price per barrel.
			Barrels.	Per cent.		
1889	500	.....	.....	.....	$2,500	$5.000
1890	1,200	.....	+ 700	+140.00	8,400	7.000
1891	1,430	.....	+ 230	+ 19.17	9,950	6.958
1892	5,080	.....	+ 3,650	+255.24	5,480	1.079
1893	18,010	0.04	+ 12,930	+254.53	18,060	1.003
1894	40,130	.08	+ 22,120	+122.82	40,810	1.017
1895	44,467	.08	+ 4,337	+ 10.81	26,910	.605
1896	115,141	.19	+ 70,674	+158.93	52,587	.457
1897	147,648	.24	+ 32,507	+ 28.23	71,914	.487
1898	616,600	1.11	+ 468,952	+317.62	305,875	.496
1899	738,183	1.29	+ 121,583	+ 19.72	523,068	.709
1900	917,225	1.44	+ 179,042	+ 24.25	945,992	1.031
1901	989,696	1.43	+ 72,471	+ 7.90	778,097	.787
1902	986,720	1.12	− 2,976	− .30	745,803	.756
1903	1,573,085	1.57	+ 586,365	+ 59.42	1,645,936	1.046
1904	6,186,629	5.28	+ 4,613,544	+293.28	5,859,982	.947
1905	12,533,777	9.30	+ 6,347,148	+102.60	6,908,002	.551
1906	22,839,911	18.05	+10,306,134	+ 82.23	10,357,923	.454
1907	46,896,267	28.23	+24,056,356	+105.33	19,239,085	.410
1908	48,823,747	27.35	+ 1,927,480	+ 4.11	19,134,658	.392
1909	50,833,740	27.75	+ 2,009,993	+ 4.12	18,863,436	.371
1910	59,217,582	28.26	+ 8,383,842	+ 16.49	23,163,676	.391
1911	66,595,477	30.21	+ 7,377,895	+ 12.46	31,928,308	.479
1912	65,473,345	29.48	− 1,122,132	− 1.68	45,300,669	.692
1913	84,920,225	34.18	+19,446,880	+ 29.70	80,767,758	.951
1914	[a] 97,995,400	36.87	+13,075,175	+ 15.40	78,671,902	.803
1915	123,295,867	43.86	+25,300,467	+ 25.82	72,537,701	.588
	691,807,062	19.13	.....	.....	417,914,382	.604

[a] Does not include 19,550,000 barrels produced in 1914 in the Cushing and Healdton fields in Oklahoma and placed in field storage.

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Petroleum marketed, value, and average price per barrel in the Mid-Continent field, 1906–1915, by States.

Year.	Kansas and Oklahoma.			Northern Texas.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1906	21,718,648	$9,615,198	$0.443	1,117,905	$740,542	$0.662
1907	45,933,649	18,478,658	.402	912,618	721,577	.791
1908	47,600,546	18,441,538	.387	723,264	479,072	.662
1909	49,122,982	17,920,623	.364	681,940	393,732	.577
1910	53,157,386	20,367,423	.383	969,403	505,396	.521
1911	57,348,456	27,060,523	.472	2,251,193	1,213,960	.539
1912	53,019,867	35,768,302	.674	5,275,529	4,112,826	.779
1913	65,954,413	61,830,231	.937	9,184,252	9,125,185	.992
1914	[a] 76,735,309	59,686,261	.778	9,451,622	7,778,955	.823
1915	100,738,730	58,409,024	.580	7,475,103	4,663,334	.624

Year.	Northern Louisiana.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1906	3,358	$2,183	$0.650	22,839,911	$10,357,923	$0.454
1907	50,000	38,850	.277	46,896,267	19,239,085	.410
1908	499,937	214,048	.428	48,823,747	19,134,658	.392
1909	1,028,818	549,081	.533	50,833,740	18,863,436	.371
1910	5,090,793	2,290,857	.450	59,217,582	23,163,676	.391
1911	6,995,828	3,653,725	.522	66,595,477	31,928,208	.479
1912	7,177,949	5,419,541	.755	65,473,345	45,300,669	.692
1913	9,781,560	9,812,342	1.003	84,920,225	80,767,758	.951
1914	11,808,469	11,206,686	.949	97,995,400	78,671,902	.803
1915	15,082,034	9,365,343	.621	123,295,867	72,537,701	.588

[a] Does not include 19,550,000 barrels produced in 1914 in the Cushing and Healdton fields in Oklahoma and placed in field storage.

Petroleum marketed in the Mid-Continent oil field, 1911–1915, in barrels.

Month.	1911	1912	1913	1914	1915
January	4,919,020	4,955,463	6,271,174	8,040,993	8,056,578
February	4,683,538	4,895,427	5,951,436	7,246,321	8,238,192
March	7,080,046	5,158,823	6,721,358	9,226,714	9,347,651
April	5,952,082	5,145,162	6,958,467	8,593,260	13,305,842
May	5,742,241	5,539,186	7,473,214	9,161,922	9,959,767
June	5,584,423	5,187,674	7,289,629	9,081,738	10,496,781
July	5,488,403	5,557,030	7,317,115	8,873,008	11,502,611
August	5,386,153	5,806,372	6,916,638	6,838,026	10,488,990
September	5,466,028	5,545,693	7,097,031	6,274,724	10,303,259
October	5,680,980	6,113,379	7,617,577	7,901,451	10,032,814
November	5,352,694	5,641,809	7,535,142	8,193,649	10,018,127
December	5,258,069	5,927,327	7,771,444	8,563,594	11,545,255
	66,595,477	65,473,345	84,920,225	97,995,400	123,295,867

Average daily production of petroleum in the Mid-Continent oil field, 1911–1915, in barrels.

Month.	1911	1912	1913	1914	1915
January	158,697	159,208	202,296	259,387	259,890
February	167,269	168,808	212,551	258,797	294,221
March	228,408	166,414	216,818	297,636	301,537
April	198,403	171,505	231,949	286,442	443,528
May	185,234	178,683	241,071	295,546	321,283
June	186,147	172,932	242,988	302,725	349,893
July	177,045	179,259	236,036	286,226	371,052
August	173,747	187,302	223,117	220,582	338,355
September	182,221	184,856	236,568	209,157	343,442
October	183,257	197,206	245,728	254,886	323,639
November	178,423	188,060	251,171	273,122	333,938
December	169,615	191,204	250,692	276,245	372,428
Average	182,453	178,889	232,658	268,481	337,797

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PIPE-LINE RUNS, DELIVERIES, AND STOCKS.

Pipe-line runs and deliveries to trade of petroleum from the Mid-Continent field and stocks at end of each month in 1914 and 1915, in barrels.

Month.	1914			1915		
	Runs.	Deliveries.	Stocks.	Runs.	Deliveries.	Stocks.
Dec. 31, 1913	.....	.....	57,391,846	.....	.....	.....
January	8,040,993	6,919,479	58,513,360	8,056,578	4,811,588	64,062,684
February	7,246,321	6,843,355	58,926,326	8,238,192	7,151,789	65,149,087
March	9,226,714	8,833,892	59,309,148	9,347,651	8,057,726	66,439,012
April	8,593,260	7,478,268	60,424,140	13,305,842	4,261,707	75,483,147
May	9,161,922	7,605,413	61,980,649	9,959,767	8,297,011	77,145,903
June	9,081,738	7,164,284	63,898,103	10,496,781	7,551,049	80,091,635
July	8,873,008	7,318,108	65,453,003	11,502,611	11,210,245	80,384,001
August	6,838,026	6,747,414	65,543,615	10,488,990	10,436,768	80,436,223
September	6,274,724	7,803,882	64,014,457	10,303,259	11,149,404	79,590,078
October	7,901,451	9,728,614	62,187,294	10,032,814	10,774,658	78,848,234
November	8,193,649	9,202,788	61,178,155	10,018,127	13,828,412	75,037,949
December	8,563,594	8,924,055	60,817,694	11,545,255	12,286,787	74,296,417
	97,995,400	94,569,552	.....	123,295,867	109,817,144	.....

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade journal sources and differ somewhat from those on pages 589–591, which are obtained from reports received directly from the oil producers:

Wells completed in the Mid-Continent field, 1911–1915.

District.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Kansas	172	536	1,422	1,753	610	96	160	260	270	147	418	949	2,016	2,340	1,088
Oklahoma	3,294	4,712	6,965	6,410	3,397	489	843	1,308	1,343	885	4,067	5,993	8,851	8,292	4,624
Northern Texas	84	299	581	497	195	38	124	208	221	91	126	434	799	744	308
Northern Louisiana	246	239	356	302	349	63	62	92	91	89	341	353	518	445	464
	3,796	5,786	9,324	8,962	4,551	686	1,189	1,868	1,925	1,212	4,972	7,729	12,184	11,821	6,484

[a] Including gas wells.

Oil wells and dry holes drilled in the Mid-Continent field in 1915.

District.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Kansas	47	9	38	24	15	1	10	5	7	7	7	4	12	12
Oklahoma	213	56	225	52	195	63	236	56	214	39	219	51	205	45
Northern Texas	14	6	21	9	18	5	21	4	15	9	10	5	5	5
Northern Louisiana	16	5	22	9	20	5	32	7	35	1	41	13	35	6
	290	76	306	94	248	74	299	72	271	56	277	73	257	68

District.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Kansas	27	14	26	6	68	13	131	26	222	26	610	147
Oklahoma	216	58	178	82	364	81	497	164	635	138	3,397	885
Northern Texas	16	7	11	10	12	8	25	9	27	14	195	91
Northern Louisiana	35	12	34	4	26	8	25	11	28	8	349	89
	294	91	249	102	470	110	678	210	912	186	4,551	1,212

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Wells completed in the Mid-Continent field, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	254	152	488	976	290	45	32	111	211	76	328	207	669	1,260	422
February	290	317	553	921	306	29	78	98	185	94	344	444	715	1,186	456
March	349	335	514	1,067	248	39	64	100	226	74	421	437	660	1,368	358
April	413	456	624	1,026	299	71	98	76	263	72	528	615	758	1,377	426
May	378	486	811	1,113	271	68	103	162	246	56	482	653	1,083	1,461	361
June	279	576	867	949	277	74	120	191	155	73	417	776	1,180	1,176	385
July	254	558	880	734	257	57	95	237	144	68	364	706	1,207	945	376
August	243	567	927	639	294	47	93	176	104	91	304	729	1,186	812	439
September	262	532	839	562	249	34	107	139	104	102	351	711	1,062	712	430
October	249	588	881	373	470	39	146	177	87	110	322	822	1,144	556	632
November	317	637	953	269	678	61	158	184	90	210	407	890	1,223	448	996
December	262	582	987	333	912	59	95	217	110	186	363	739	1,297	520	1,203
	[b]3,796	5,786	9,324	8,962	4,551	[b] 686	1,189	1,868	1,925	1,212	[b] 4,972	7,729	12,184	11,821	6,484

[a] Including gas wells.

[b] Caddo, La., not given by months.

Initial daily production of new wells completed in the Mid-Continent field in 1915, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Kansas	843	974	230	105	110	130	225	530	370	790	1,927	5,085	11,319
Oklahoma	123,484	117,313	85,070	149,406	124,455	113,210	76,440	48,698	24,730	61,242	64,248	47,874	1,036,170
Northern Texas	507	1,150	750	633	665	630	800	955	700	385	1,138	1,180	9,493
Northern Louisiana	4,390	11,045	20,435	18,645	19,290	13,350	24,516	23,235	30,350	9,920	13,450	9,490	198,116
	129,224	130,482	106,485	168,789	144,520	127,320	101,981	73,418	56,150	72,337	80,763	63,629	1,255,098

Total and average initial daily production of new wells in the Mid-Continent field, 1911–1915, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Kansas	3,271	7,245	22,467	18,932	11,319	19.0	13.5	15.8	10.8	18.6
Oklahoma	262,333	228,886	334,050	976,244	1,036,170	79.6	48.6	48.0	152.3	305.0
Northern Texas	19,180	28,213	57,435	25,003	9,493	228.3	94.3	98.9	50.3	48.7
Northern Louisiana	169,123	84,098	151,955	102,193	198,116	687.5	351.9	426.8	338.4	567.7
	453,907	348,442	565,907	1,122,372	1,255,098	119.6	60.2	60.7	125.2	275.8

Total initial daily production of new wells in the Mid-Continent field, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1911	23,525	26,970	40,855	31,168	28,828	24,225	16,968
1912	19,283	22,437	24,429	37,573	24,592	22,099	23,971
1913	29,305	35,551	36,189	54,518	59,191	55,466	48,142
1914	38,308	53,507	90,341	73,165	121,193	152,760	95,017
1915	129,224	130,482	106,485	168,789	144,520	127,320	101,981

Year.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911	12,934	17,274	20,754	22,738	18,545	[a] 453,907	37,826
1912	30,153	36,468	38,877	37,573	30,987	348,442	29,037
1913	53,929	41,405	48,436	40,756	63,019	565,907	47,159
1914	104,984	96,098	83,923	75,401	137,675	1,122,372	93,531
1915	73,418	56,150	72,337	80,763	63,629	1,255,098	104,592

[a] Caddo, La., not given by months.

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PRICES.

The following table shows the changes in prices of Mid-Continent oil in 1914 and 1915, and the dates on which the changes were made:

Prices of Mid-Continent oil per barrel in 1914 and 1915, by grades.

1914.

Date.	Kansas and Oklahoma.	Healdton, Okla.	Northern Texas.				Northern Louisiana (Caddo, De Soto, and Red River).
			Corsicana (light).	Henrietta.	Powell (heavy).	Electra.	
Jan. 1	$1.03		$1.05	$1.05	$0.80	$1.05	$0.75–$1.05
Jan. 26		$1.03					
Feb. 2	1.05						
Mar. 2		$0.70–1.03			.70		
Mar. 9		.70–1.05					
Mar. 26		.70					
Apr. 3							.60– 1.05
Apr. 8	1.00						
Apr. 10	.95						
Apr. 13	.90	.60	.95	.95	.60	.95	
Apr. 15	.85						
Apr. 17							.50– 1.05
Apr. 20		.50	.85	.85	.50	.85	
Apr. 27	.80						
Apr. 30	.75						
May 5			.75	.75		.75	
July 9							.50– 1.00
Aug. 8							.45– .95
Aug. 13							.45– .85
Sept. 1							.45– .80
Sept. 12	.65						
Sept. 22	.55		.70	.70		.70	
Oct. 6			.65	.65		.65	
Nov. 13			.60	.60		.60	

1915.

Date.	Kansas and Oklahoma.	Healdton, Okla.	Northern Texas.			Northern Louisiana.		
			Corsicana (light), Henrietta, Electra, and Moran.	Powell (heavy).	Thrall and Strawn.	Caddo.	De Soto and Sabine.	Red River.
Jan. 1	$0.55	$0.50	$0.55	$0.55		$0.45–$0.80	$0.80	$0.50
Feb. 2		.30						
Feb. 8	.45							
Feb. 15	.40		.45	.40				
Feb. 18						.45– .70	.70	
Mar. 3							.60	
Mar. 24						.45– .60	.50	
Mar. 26						.35– .60		
May 3					$0.45			
July 13								.45
July 16								(a)
July 20								.40
Aug. 2	.50							
Aug. 4	.55		.55					
Aug. 6			.60		.55			
Aug. 11	.60							
Aug. 13			.65		.60			
Aug. 19	.65							
Aug. 21	.75		.70					
Aug. 26			.75		.65			
Aug. 27						.40– .65	.55	.45
Sept. 11	.80				.70			
Sept. 16			.80		.75	.45– .70	.60	.50
Sept. 22						.50– .75	.65	.55
Sept. 24		.35						
Oct. 6						.55– .80	.70	.60
Oct. 11		.40						
Oct. 25		.45		.45				
Nov. 13	.90							
Nov. 15	1.00	.55	1.00	.55	.95			
Nov. 18						.65– .90	.80	.70
Nov. 20						.75– 1.00	.90	.80
Dec. 13	1.10							
Dec. 14	1.20	.60	1.20	.60	1.05			
Dec. 17						.80– 1.10	1.00	.85
Dec. 28						.80– 1.20	1.10	

a On July 16 the Texas Co. reduced the price of Red River oil to $0.35, advancing it to $0.45 Aug. 28.

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Average monthly price per barrel of Mid-Continent petroleum in 1914 and 1915.

1914.

Month.	Kansas and Oklahoma.	Healdton, Okla.	Northern Texas.				Northern Louisiana (Caddo, De Soto, and Red River).
			Corsicana (light).	Henrietta.	Powell (heavy).	Electra.	
January	$1.03	$1.05	$1.05	$1.80	$1.05	$0.75–$1.05	$1.03
February	1.01	1.05	1.05	1.80	1.05	.75– 1.05	1.03
March	1.05	1.05	1.05	.74	1.05	.75– 1.05	$0.72– .98
April	.91	.95	.95	.60	.95	.56– 1.05	.56
May	.75	.76	.76	.50	.76	.50– 1.05	.50
June	.75	.75	.75	.50	.75	.50– 1.05	.50
July	.75	.75	.75	.50	.75	.50– 1.01	.50
August	.75	.75	.75	.50	.75	.46– .90	.50
September	.66	.74	.74	.50	.74	.45– .80	.50
October	.55	.66	.66	.50	.66	.45– .80	.50
November	.55	.62	.62	.50	.62	.45– .80	.50
December	.55	.60	.60	.50	.60	.45– .80	.50
Average	.76	.81	.81	.75	.81	.55– .95	.61

1915.

Month.	Kansas and Oklahoma.	Healdton, Okla.	Northern Texas.			Northern Louisiana.		
			Corsicana (light), Henrietta, Electra, and Moran.	Powell (heavy).	Thrall and Strawn.	Caddo.	De Soto and Sabine.	Red River.
January	$0.55	$0.50	$0.55	$0.50	.....	$0.45–$0.80	$0.80	$0.50
February	.45	.31	.50	.45	.....	.45– .76	.76	.50
March	.40	.30	.45	.40	.....	.41– .67	.58	.50
April	.40	.30	.45	.40	.....	.35– .60	.50	.50
May	.40	.30	.45	.40	$0.45	.35– .60	.50	.50
June	.40	.30	.45	.40	.45	.35– .60	.50	.50
July	.40	.30	.45	.40	.45	.35– .60	.50	.45
August	.63	.30	.64	.40	.57	.36– .61	.51	.41
September	.78	.31	.78	.40	.71	.44– .69	.59	.49
October	.80	.40	.80	.41	.75	.54– .79	.69	.59
November	.91	.50	.91	.40	.86	.63– .88	.78	.63
December	1.12	.58	1.12	.58	1.01	.78– 1.06	.96	.82
Average	.60	.37	.63	.43	.66	.46– .75	.64	.53

KANSAS.

GENERAL STATEMENT.

The quantity of petroleum marketed from the districts in Kansas in 1915 was greater than in any preceding year with the exception of 1914 and was less by only 9 per cent than the record yield in that year. In consideration of the proximity of Kansas to the areas of excessive production in Oklahoma and of the fact that oil produced in Kansas is classed with the Oklahoma product and was subjected to the extreme price reductions that affected the latter during the closing months of 1914 and the first seven months of 1915, the showing made by the Kansas fields in 1915 is remarkable.

Although the greater part of the output in 1915 came from districts proved long prior to 1915, a considerable part was contributed by the Augusta district in Butler County, first demonstrated as an area of oil production in 1914, and by the El Dorado district, likewise in Butler

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County, the discovery of which constituted the feature of developments in Kansas in 1915.

The potential capacity of these two districts as demonstrated in the closing months of 1915, the advancing market for oil during the same period, and the resulting increase in drilling activity all over the State allow no other conclusion than that new records of production will be established in the Kansas fields in 1916.

DEVELOPMENT.

The slight activity in the quest for oil in Kansas during the early months of 1915 was restricted in the main to areas of proved worth, and it was not until October that developments of consequence were recorded.

The first of these began with the bringing in about the middle of October of a 100-barrel well near El Dorado, Butler County, about 15 miles northeast of the Augusta pool. This well is in the NE. ¼ SE. ¼ sec. 29, T. 25 S., R. 5 E., on the Stapleton farm, and was drilled by the Continental Oil & Gas Co. (now Empire Gas & Fuel Co.). The discovery was in a sand penetrated at a depth of about 660 feet. Offset wells drilled in the following month confirmed the importance of the shallow discovery, but this sand was mudded off in the pioneer well and drilling was continued.

About the middle of December a lower zone of production was discovered at a reported depth of 2,460 feet and the well was completed with an initial production of 120 barrels a day. At the end of the year nine productive oil wells had been completed in the El Dorado district, all of which, with the exception of No. 1 Stapleton, were producing from shallow sands found at approximate depths of 540 and 660 feet below the surface.

The second development of consequence, in point of time, began in the early part of November and resulted from the completion, at a reported depth of 60 feet, as a 15-barrel well, of a wildcat test drilled by Duffield & Dunaway in the southeast corner of the SE. ¼ NW. ¼ sec. 9, T. 17 S., R. 22 E., on the J. H. Wingert farm, in Miami County. The importance of this well was not due so much to its capacity as to its location, 7 miles northwest of the town-lot pool at Paola. This discovery served to revive activity in the Paola locality as well as in the shallow Rantoul pool in Franklin County to the west, and before the close of 1915 several creditable producers had been drilled in these districts.

The third development of importance in Kansas took place in the Augusta district, which, prior to 1914, was an area of gas production only. As recorded in the preceding report of this series, oil was discovered in this district in 1914 in a sand reached at an approximate depth of 2,500 feet and five oil wells were completed in the heart of the gas field before the end of that year. About the middle of December drilling for oil in this district was renewed by the Continental Oil & Gas Co. and before the close of 1915 the number of oil wells was increased to 12, one of which, No. 4 E. C. Varner, located in the NE. ¼ sec. 17, T. 28 S., R. 4 E., was credited with an initial output of 1,500 barrels, natural flow.

A little additional drilling in 1915 in the vicinity of the successful wildcat test completed in 1914 near Winfield, in Cowley County, failed to develop anything of importance.

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Deep tests, of interest on account of their location, though unsuccessful from the standpoint of production of oil or gas, were abandoned in Kansas in 1915 as follows:

Clark County: November—Short Grass Oil & Gas Co.; 1 mile west of Minneola, in T. 30 S., R. 25 W.; depth, 3,807 feet.

Butler County: November—Benedum & Trees; in sec. 5, T. 29 S., R. 4 E., on the Walter Hartenbower farm, 2 miles north of Douglass; depth, 3,400 feet.

Harper County: December—Thompson Bros.; near the town of Harper; depth, 3,300 feet.

Cowley County: January—Winfield Petroleum Co.; in the NW. ¼ sec. 13, T. 32 S., R. 4 E., on the Rockwell farm; depth, 2,400 feet. Continental Oil & Gas Co.; in sec. 9, T. 30 S., R. 7 E., 7 miles south of Latham, on the McHanah farm; depth, 2,600 feet.

MARKETED PRODUCTION.

Petroleum marketed in Kansas, 1914 and 1915, in barrels.

1914.

Month.	Runs to local refineries.	Other runs and field fuel.	Rail shipments not included in pipe-line runs.	Total.
January	44,906	212,547	2,890	260,343
February	38,473	209,790	2,158	250,421
March	47,137	243,705	789	291,631
April	47,426	215,152	155	262,733
May	44,522	236,208	192	280,922
June	45,768	238,492	576	284,835
July	47,219	245,369	384	292,972
August	36,794	197,667	384	234,845
September	31,624	206,938	346	238,908
October	34,571	203,630	309	238,510
November	34,928	195,593	327	230,848
December	35,652	200,446	519	236,617
	489,020	2,605,537	9,028	3,103,585

1915.

January	35,483	207,941	2,182	245,606
February	30,851	175,453	1,107	207,411
March	27,069	197,303	1,811	226,183
April	20,579	187,623	971	209,173
May	28,034	182,382	743	211,159
June	32,386	185,260	192	217,838
July	27,576	210,608	1,032	239,216
August	25,372	221,033	624	247,029
September	22,025	224,410	6,313	252,748
October	22,268	230,217	7,009	259,494
November	21,421	234,477	7,057	262,955
December	22,938	216,529	5,208	244,675
	316,002	2,473,236	34,249	2,823,487

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the tables following are compiled from trade journal sources and differ somewhat from those on page 589, obtained from reports received directly from the oil producers.

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Wells completed in Kansas, 1911–1915.

County.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Allen	30	50	154	175	49	10	6	11	10	3	59	58	171	193	65
Anderson	.....	.....	.....	1	.....	.....	.....	.....	.....	4	.....	.....	.....	1	4
Bourbon	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Butler	.....	.....	.....	5	22	.....	.....	.....	.....	4	.....	.....	.....	29	60
Chautauqua	64	182	311	308	112	11	28	77	38	26	82	222	442	376	164
Coffey	.....	.....	.....	5	3	.....	.....	.....	1	.....	.....	.....	.....	7	3
Cowley	.....	.....	.....	3	2	.....	.....	.....	8	4	.....	.....	.....	17	18
Elk	.....	.....	.....	.....	.....	4	.....	.....	3	2	4	.....	.....	3	5
Ford	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Franklin	.....	18	54	163	71	.....	.....	3	30	22	.....	18	58	225	114
Greenwood	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Labette	.....	2	.....	8	19	.....	.....	.....	18	3	1	2	3	54	29
Linn	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....
Miami	.....	.....	.....	131	33	.....	.....	.....	42	15	.....	.....	.....	186	52
Montgomery	60	202	602	691	201	22	47	92	75	49	118	365	867	903	379
Neosho	16	62	257	221	92	22	23	27	19	9	59	115	316	263	144
Sumner	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Wilson	2	18	40	27	6	27	52	45	20	4	94	156	139	59	23
Woodson	.....	1	2	12	.....	.....	3	3	2	2	.....	7	5	14	25
Miscellaneous	.....	1	2	.....	.....	.....	1	2	4	.....	1	6	15	7	.....
	172	536	1,422	1,753	610	96	160	260	270	147	418	949	2,016	2,340	1,088

[a] Including gas wells.

Oil wells and dry holes drilled in Kansas in 1915.

County.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen	3	.....	5	.....	1	.....	.....	.....	.....	.....	.....	.....	3	2
Anderson	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Butler	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Chautauqua	11	.....	15	1	2	.....	2	2	.....	2	2	1	1	2
Coffey	1	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cowley	1	3	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Elk	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....
Franklin	3	.....	2	9	4	.....	3	1	4	4	.....	1	3	2
Labette	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Miami	.....	.....	.....	.....	4	.....	.....	.....	1	.....	.....	.....	.....	.....
Montgomery	23	6	16	11	3	1	4	2	1	.....	5	1	2	4
Neosho	3	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	3	1
Wilson	2	.....	.....	2	.....	.....	1	.....	.....	.....	.....	.....	.....	.....
Woodson	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
	47	9	38	24	15	1	10	5	7	7	7	4	12	12

County.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Allen	.....	.....	.....	.....	7	.....	9	1	21	.....	49	3
Anderson	.....	4	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
Butler	4	.....	1	.....	.....	1	2	2	15	1	22	4
Chautauqua	2	2	4	3	5	1	24	6	44	6	112	26
Coffey	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	.....
Cowley	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	2	4
Elk	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
Franklin	2	.....	4	.....	9	1	10	2	27	2	71	22
Labette	.....	.....	.....	.....	6	1	4	1	9	.....	19	3
Miami	1	.....	1	1	1	3	8	6	17	5	33	15
Montgomery	16	4	13	1	27	5	32	6	59	8	201	49
Neosho	.....	.....	3	.....	13	1	40	2	30	4	92	9
Wilson	1	2	.....	.....	.....	.....	2	.....	.....	.....	6	4
Woodson	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
	27	14	26	6	68	13	131	26	222	26	610	147

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Wells completed in Kansas, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	7	4	44	207	47	8	2	6	31	9	29	9	75	266	88
February	5	11	69	194	38	5	7	9	18	24	20	27	107	228	94
March	16	10	61	199	15	7	9	12	32	1	36	27	88	251	23
April	7	23	63	191	10	7	9	13	42	5	27	46	96	254	33
May	21	37	97	230	7	10	12	29	30	7	43	75	172	284	24
June	14	46	128	203	7	10	8	30	10	4	53	72	190	228	28
July	22	60	147	153	12	9	7	31	21	12	41	77	202	201	57
August	23	80	155	115	27	9	10	20	9	14	23	115	207	144	78
September	13	56	133	95	26	2	18	23	17	6	41	106	185	133	79
October	20	63	147	61	68	7	29	32	15	13	40	138	209	119	91
November	11	81	184	50	131	15	34	24	20	26	26	155	236	114	206
December	13	65	194	55	222	7	15	31	25	26	39	102	249	118	287
	172	536	1,422	1,753	610	96	160	260	270	147	418	949	2,016	2,340	1,088

[a] Including gas wells.

Initial daily production of new wells completed in Kansas in 1915, in barrels.

County.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Allen	25	40	5	.....	.....	.....	35	.....	.....	65	95	235	500
Butler	.....	.....	.....	.....	.....	.....	.....	90	25	.....	300	2,905	3,320
Chautauqua	545	675	55	20	.....	90	40	55	75	150	240	570	2,515
Coffey	5	.....	5	.....	.....	.....	.....	10	.....	.....	.....	.....	20
Cowley	15	.....	.....	.....	40	.....	.....	.....	.....	.....	.....	.....	55
Franklin	25	20	20	15	25	.....	40	20	50	70	125	210	620
Labette	.....	.....	.....	.....	.....	.....	.....	.....	.....	30	20	55	105
Linn	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Miami	.....	.....	70	.....	15	.....	.....	10	5	5	159	198	462
Montgomery	201	289	75	65	30	40	45	335	180	340	378	577	2,505
Neosho	17	.....	.....	.....	.....	.....	65	.....	35	130	600	335	1,182
Wilson	10	.....	.....	5	.....	.....	.....	10	.....	.....	10	.....	35
	843	974	230	105	110	130	225	530	370	790	1,927	5,085	11,319

Total and average initial daily production of new wells in Kansas, 1911–1915, by counties, in barrels.

County.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Allen	353	632	2,960	1,896	500	11.8	12.6	19.2	10.83	10.20
Anderson	.....	.....	.....	10	.....	.....	.....	.....	10.00	.....
Bourbon	.....	.....	.....	5	.....	.....	.....	.....	5.00	.....
Butler	.....	.....	.....	47	3,320	.....	.....	.....	9.40	15.09
Chautauqua	1,355	2,963	7,358	5,379	2,515	21.2	16.3	23.7	17.46	22.49
Coffey	.....	.....	.....	45	20	.....	.....	.....	9.00	6.67
Cowley	.....	.....	.....	150	55	.....	.....	.....	50.00	27.50
Franklin	.....	155	748	1,360	620	.....	8.6	13.9	8.34	8.73
Labette	.....	15	.....	32	105	.....	7.5	.....	4.00	5.53
Linn	.....	.....	.....	30	.....	.....	.....	.....	15.00	.....
Miami	.....	.....	.....	920	462	.....	.....	.....	7.02	14.00
Montgomery	1,300	2,522	5,871	6,262	2,505	21.7	12.5	9.8	9.06	12.46
Neosho	208	693	5,168	2,414	1,182	13.0	11.2	20.1	10.9	12.85
Wilson	55	255	342	268	35	27.5	14.2	8.6	9.9	5.83
Woodson	.....	5	13	114	.....	.....	5.0	6.5	9.5	.....
Miscellaneous	.....	5	7	.....	.....	.....	5.0	3.5	.....	.....
	3,271	7,245	22,467	18,932	11,319	19.0	13.5	15.8	10.8	18.56

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Total initial daily production of new wells in Kansas, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911.....	155	90	304	161	438	255	285	363	265	380	265	310	3,271	273
1912.....	65	173	213	390	352	714	834	940	507	842	1,185	1,030	7,245	604
1913.....	860	1,065	1,003	1,897	1,548	1,918	1,945	2,250	2,283	2,501	2,857	2,340	22,467	1,872
1914.....	2,077	2,196	1,950	2,083	2,411	2,178	1,820	1,395	1,006	700	501	615	18,932	1,578
1915.....	843	974	280	105	110	130	225	530	370	790	1,927	5,085	11,319	943

OKLAHOMA.

GENERAL STATEMENT.

For the second time in its history, Oklahoma attained in 1915 first rank among the petroleum-producing States. Its marketed production in that year constituted 35 per cent of the entire output of oil of the United States and exceeded the corresponding output of California, its closest competitor, by more than 11,000,000 barrels, or 14 per cent. Oklahoma held first place in 1908, when for that year only the output of the newly developed Glenn pool in eastern Creek County increased the total output of petroleum in the State to a quantity slightly greater than that of California. The return of Oklahoma to first place in 1915 was again due to the marvelous oil resources of Creek County, liberated this time in the Cushing field, near its western boundary. An indication of the magnitude of Cushing's contribution in 1915 lies in the fact that it constitutes 17 per cent of the total quantity of petroleum marketed in the United States during the year and exceeds by more than 3,000,000 barrels the entire oil output of Oklahoma in its former period of supremacy.

That the commanding position of Oklahoma in the petroleum industry is not based on quantity of production alone is shown by the fact that 55 per cent of the high-grade oil marketed in the United States in 1915 came from sources within its borders. The further fact that 30 per cent of the output of high-grade oil in this country in 1915 was derived from the Cushing field alone not only indicates the remarkable potentialities of Oklahoma's oil sands but explains why a single district could dominate, as Cushing did, the entire petroleum industry during the period of its maximum development.

After a period of steadily increasing production of high-grade oil throughout the entire country, during which supply and demand had been brought nearly to a state of balance in response to an advancing market in 1913, the effect of the rapid development following the discovery of the prolific Bartlesville sand in the Cushing field late in 1913 was to throw the entire industry out of adjustment by rendering available more oil than the markets could absorb.

The mounting surplus of crude oil quickly brought conviction of the tremendous potentialities of the field, and early in April, 1914, the overstrained market began a decline which affected every type of high-grade oil produced in the United States and caused a decided curtailment of activity in practically every oil field in the country except Cushing. The market decline was considerably accelerated in the midsummer months of 1914 as a consequence of the demoralized export market that resulted from the outbreak of the European war, which temporarily deprived refiners of an outlet for their products.

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Meanwhile the Cushing field had increased its output of oil from 25,000 barrels a day at the close of 1913 to 225,000 barrels a day at the close of 1914 and had secured a monopolistic grip on the markets for high-grade oil. A temporary decline in the output of oil in this field in January reacted favorably on the market for Appalachian grades for a few weeks in the early part of 1915, but increased Cushing production, amounting in April to nearly 300,000 barrels a day, caused a reversal that carried prices to the lowest level they have attained in many years. By June, 1915, however, the flush production of the field had been exhausted and the output began a decline that continued steadily to the end of the year. This decline and the prompt purchase and withdrawal from the open market of the vast accumulations of oil in field storage in and near Cushing by companies strong in business foresight and financial backing hastened the end of Cushing's domination of the industry, and in August the market began a recovery which had by no means spent its force before the close of 1915.

Outside of Cushing, where drilling was forced by conditions of local competition, field activity was everywhere curtailed to the limits of lease requirements until late in 1915, when advancing prices for crude oil indicated a growing demand for the product of other fields. A total of 4,624 wells were completed in 1915, of which 3,397, or 73 per cent, produced oil; 342, or 8 per cent, produced gas only; and 885, or 19 per cent, were barren. Fully one-third of the total completions recorded were made in the months of November and December.

DEVELOPMENT.

NORTHEASTERN OKLAHOMA.

Cherokee district.—Aside from a small number of routine completions in the proved areas the results of activity in the Cherokee district include the discovery and partial development of one new pool of oil, which, however, gave little promise of future importance.

This pool was discovered in July as a consequence of the completion in supposed gas territory of a 50-barrel oil well drilled by the New York & Oklahoma Oil Co. (A. D. Morton) on the Hopkins lease, in sec. 31, T. 23 N., R. 15 E., about 1 mile southeast of Vera in the extreme southeast corner of Washington County.

The pay sand was found at a depth of about 1,250 feet. Subsequent drilling proved the productive area to extend northeastward into sec. 29, eastward into sec. 32 of this township, and southwestward into sec. 6 of the adjoining township on the south.

In the shallow-sand area in Nowata County the successful completion of an advance test on the Stamm farm, in sec. 26, T. 29 N., R. 15 E., attracted activity to a locality where the pay sand is found at a depth of about 850 feet and new wells average from 10 to 20 barrels in output.

Northeast of Tulsa a number of exceptionally good wells were completed in the Mohawk pool, in sec. 21, T. 20 N., R. 13 E.

Osage district.—Operations in the Osage district in 1915 resulted in the opening of no new areas of production. The interest of the operators was centered in efforts to secure a renewal of the Foster lease, which was to expire March 16, 1916.

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The original lease was made March 16, 1896, for a period of 10 years by the Osage Nation to Edwin B. Foster, and covered oil and gas rights on the entire reservation. This lease was subsequently assigned by Foster to the Indian Territory Illuminating Oil Co., which retained the gas rights but subleased the oil rights to a great number of independent operators. By act of Congress (Public No. 112) dated March 3, 1905, this blanket lease was renewed to the extent of 680,000 acres in the eastern part of the reservation and extended for a further period of 10 years, terminating in 1916. After hearings on the subject the Secretary of the Interior announced, in June, 1915, a resolution passed by the Osage Council and approved by the Department of the Interior, providing for the re-leasing of the area involved in the Foster lease under terms which eliminate the Indian Territory Illuminating Co. as an intermediary.

This resolution provides for new leases direct to existing sublessees and covering their holdings in quarter-section units not exceeding in the aggregate 4,800 acres each, except such units the producing wells of which were capable of averaging 25 or more barrels of oil a day on July 1, 1915. These units are to be retained by the Osage tribe and offered for lease at public auction to the highest bidder under such rules and regulations as the Secretary of the Interior shall provide. Leases on all producing lands not leased to former holders are made subject to the same form of disposition. The stipulations are made that oil and gas rights shall be leased separately; that the royalty rate on oil shall be one-sixth, except on quarter-section units the average daily production of which equals or exceeds 100 barrels per well for calendar-month periods, when the royalty rate increases to one-fifth; and that instead of a flat annual rental for gas wells, as heretofore, a production royalty of one-sixth shall be collected. The term prescribed for oil leases is five years, subject to renewal so long as oil is produced but not beyond the date when the title to minerals in the Osage tribe terminates, which is August 8. 1931.

Activity in the Osage in 1915 was more pronounced in the area north of Bigheart than elsewhere and a number of wells of fair capacity were completed.

Creek County.—Outside the developments in the Cushing field, near the western boundary, operations in Creek County in 1915 were negligible. In the Cushing field the year's developments added little to the areal extent of the productive territory as roughly outlined at the close of 1914. Line drilling and, on many leases, "inside" development furnished the greater proportion of the production. As defined at the close of 1915, the Cushing field has an extent from north to south of approximately 10 miles, a width ranging between 3 and 5 miles, and a proved acreage of, roughly, 10,000 acres. Although the southern portion of the field in the vicinity of Drumright and Tiger, where the prolific Bartlesville sand was first tapped in 1913, has an enviable record for wells of large capacity, it is not to be compared with the territory to the north, in T. 18 N., R. 7 E., where the largest wells in the history of the State were found, one of which, No. 10 on the Benoche Fixico lease, in sec. 17, completed in July by the Mid-Co. Petroleum Co., gaged 10,752 barrels for the first day's run and 10,848 barrels for the second, settling, however, to a 4,000-barrel rate within a week after completion. The discovery early in 1915 by deeper drilling of a prolific "pay" in the lower part of the Bartlesville sand in this part of the field resulted in

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the deepening of a great many of the wells and the development of the gusher production that raised the output of the field to approximately 300,000 barrels a day for a brief period in April. With the decline of production from the Bartlesville sand in the last half of 1915, increased attention was given to the development of production in the shallower Layton sand that had been cased off in the earlier rush for the gusher sand.

Marketing facilities in the Cushing field were notably increased in 1915. A railroad connecting with the Frisco at Jennings was built and put in operation as far south as Drumright. The Oklahoma Pipe Line Co. extended its 8-inch trunk line from the Glenn pool to the field. The McMan Oil Co. constructed and put into operation an 8-inch line from its properties in the field to Addington, a distance of 138 miles, where connection was made with the trunk line of the Magnolia Petroleum Co. A 6-inch line was built by the Hill Oil & Gas Co. from its producing properties to a tank farm at Depew, 7 miles distant. The Milliken Refining Co. laid a 6-inch line from this field to Alluwe. The Twin State Refining Co. (Sun Co.) laid a 4-inch line from the field to its refinery at Yale. Three-inch pipe lines were laid by the Indiahoma Refining Co. and the Slick Oil Co. from the Cushing field to Bristow, a distance of 15 miles. Eighty miles of 4-inch line was laid by the Ponca Refining Co. from Yale to the company's refinery at Ponca City. Both the Prairie and the Gulf Pipe Line companies increased the capacity of their trunk lines from Oklahoma as a consequence of the enormous production developed in the Cushing field.

At the close of the year interest in western Creek County was centered in the development of a new pool of oil and gas 4 miles south of the southern limits of the Cushing field, following the completion in August of an oil well by the Gypsy Oil Co. on the Trent lease, in the NW. ¼ sec. 9, T. 16 N., R. 7 E. The oil was found in the Layton sand at a reported depth of 1,530 feet and the initial flow was 500 barrels. This well is in a locality where previous tests had resulted in gas wells, with the exception of one drilled in February, which reported a 500-barrel showing of oil at 1,680 feet. The showing was not developed, however, the well being drilled deeper into the Bartlesville sand and eventually ruined by salt water. The relatively shallow depth of the productive sand favored the rapid development of the pool, and before the end of 1915 the productive area had been extended to the north into sec. 4 and to the south into sec. 16, T. 16 N., R. 7 E.

Kay County.—A feature of oil-development work in northern Oklahoma in 1915 was the demonstration that an important pool of oil exists near Blackwell, in Kay County. In the later part of July the Spencer Oil Co. completed an oil well in the SE. ¼ sec. 32, T. 29 N., R. 1 E., which yielded an initial flow of 600 barrels from a sand entered at 3,360 feet and penetrated to a depth of 27 feet and confirmed the discovery of oil at about the same depth made in 1914 in the Jones & Buell well on the Swenson farm, half a mile to the northeast. Further evidence of an encouraging nature was furnished by the Duluth-Oklahoma Oil Co.'s well on the Wolf farm, 1½ miles southwest of the Alberti well, completed as a gas well about the same time and at about the same depth as the latter, and having an estimated capacity of 12,000,000 cubic feet of gas a day and a rock pressure of 1,500 pounds to the square inch. Additional wells were started in

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the locality, but the depth involved rendered drilling progress slow, and none of the tests was completed before the end of 1915.

EAST-CENTRAL OKLAHOMA.

Wagoner County.—A development of considerable potential importance resulted in the later part of 1915 from the discovery of oil at 1,250 feet in wells drilled on the south side of Arkansas River in sec. 5, T. 16 N., R. 15 E., near the town of Stone Bluff, in the southwest corner of Wagoner County. At the close of the year the new pool had five oil wells, rated at capacities of 300 to 500 barrels a day each when completed.

Muskogee County.—Outside the Cushing field the most active district in Oklahoma in 1915 was in Muskogee County, where many excellent wells were completed in the Boynton and Cole pools, the productive areas of which were extended and where two new pools were discovered. Near the center of sec. 6, T. 14 N., R. 16 E., a small pool northwest of the prolific Boynton pool and designated the Harris pool was a development of the year, production being obtained from the 1,600-foot zone of production. In the north-central part of the county a wildcat test, completed in January in sec. 13, T. 15 N., R. 17 E., as a 250-barrel oil well, furnished the incentive for a rapid and somewhat disastrous development, which in the course of a few weeks resulted in the completion of 4 oil wells, 2 gassers, and 35 dry holes.

Late in the year the completion of a gas well estimated to have an initial capacity of 6,000,000 cubic feet, open flow, in sec. 19 of the same township, near the village of Taft, resulted in additional tests, which, however, remained uncompleted at the end of 1915.

Okmulgee County.—In the various pools in Okmulgee County, where production is derived mainly from the erratic Boock sands, the moderate activity in 1915 resulted in no developments of importance.

McIntosh County.—Aside from a small oil pool in sec. 6, T. 11 N., R. 14 E., which furnished a few good wells in 1915, the oil resources of McIntosh County attracted little attention until late in the year, when many advance tests were started. A number of gas wells of large capacity were completed in the northeastern part of the county near Checotah.

Okfuskee County.—The principal development of interest in Okfuskee County was the completion of the "mystery" well, drilled in sec. 8, T. 12 N., R. 7 E., by the Prairie Oil & Gas Co. in 1914 but capped without having been tested. In August the well was tubed and proved to be a 65-barrel pumper that furnished considerable water with the oil and showed no improvement with deeper drilling. A number of tests were started in the locality which should serve to demonstrate the possibilities of a new field in 1916.

Lincoln County.—In sec. 15, T. 12 N., R. 4 E., the Oilright Oil Co. completed an unsuccessful test near Meeker at a reported depth of 3,750 feet.

SOUTHERN OKLAHOMA.

Pittsburg County.—Interest in Pittsburg County was centered in a deep test by the Gypsy Oil Co. in sec. 6, T. 6 N., R. 14 E., near McAlester, which had reached a reported depth of 4,050 feet at the close of 1915.

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Pontotoc County.—A number of tests in the vicinity of the shallow-sand Allen pool failed to increase the area from which oil production is derived. A small refinery to handle the output of this pool was erected at Allen by the Crystal White Refining Co. In the immediate vicinity of Ada several excellent gas wells were completed.

Haskell County.—Unsuccessful tests were completed in 1915 by Owen & Flanagan in sec. 36, T. 9 N., R. 20 E., near Stigler, at a depth of 2,500 feet, and by McGranahan & Longfellow in sec. 33, T. 9 N., R. 21 E., near Dustin, at a depth of 2,310 feet.

Hughes County.—The discovery of oil and gas in a wildcat test in the NE. ¼ sec. 4, T. 7 N., R. 8 E., near Holdenville, Hughes County, in July aroused considerable interest. The showings were found in a sand reached at 3,035 feet in a well drilled on the Kernal farm by the Penn-West Oil Co. Deeper drilling to 3,200 feet failed to yield encouraging results, and in December the well was plugged back and shot in the discovery sand, yielding an initial flow of oil estimated at 50 barrels, accompanied by considerable water. Additional tests were started in the locality.

Le Flore County.—An unsuccessful test drilled by C. B. Shaffer in sec. 10, T. 5 N., R. 25 E., near Heavener, was abandoned in September at a reported depth of 2,400 feet.

Atoka County.—In sec. 23, T. 3 S., R. 12 E., a wildcat test drilled by C. E. Douglass was abandoned, dry, in June at a reported depth of 1,700 feet.

Carter County.—Lack of adequate marketing facilities retarded development in the Healdton field until late in 1915, when conditions were improved by the completion of an 8-inch line by the Producers Pipe Line Co. from the field to Gainesville, Tex., where an outlet was provided by the plant of the Producers Refining Co., erected during the year. Aside from creditable wells in various parts of the field, especial interest was centered in a number of gusher wells in sec. 6, T. 4 S., R. 3 W., at the northwest end of the field, the initial capacity of which ranged as high as 4,700 barrels of oil, and in the large-volume gas wells that were completed in sec. 15 of the same township in the southeastern part of the field.

Until December 15 runs of oil from this field through the common-carrier pipe lines were prorated among the producers under the supervision of the Oklahoma Corporation Commission, as a consequence of which considerable oil was placed in field storage during the year. In December, however, prorating of oil in this field was discontinued, and further additions to field stocks were slight.

At the close of 1915 interest in the Healdton district was focused on an important wildcat well being drilled by the Gypsy Oil Co. in sec. 28, T. 2 S., R. 3 W., which had penetrated two prolific gas sands, one at a reported depth of 1,845 feet and the other at about 2,000 feet, and was yielding a combined initial flow estimated at 20,000,000 cubic feet before the end of December.

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MARKETED PRODUCTION.

Petroleum marketed in Oklahoma in 1914 and 1915, in barrels.

1914.

Month.	Glenn.	Cushing.	Healdton.[a]	Other.	Total.
January	839,483	652,076	15,315	4,388,308	5,895,182
February	769,809	751,637	64,741	3,731,696	5,317,883
March	871,334	1,577,168	157,035	4,239,589	6,845,126
April	849,316	1,668,866	129,928	3,893,752	6,541,862
May	897,397	2,040,454	207,141	3,964,709	7,109,701
June	852,901	1,904,627	315,446	3,770,712	6,843,686
July	828,350	1,691,460	394,251	3,671,066	6,585,127
August	535,027	1,442,817	368,355	2,447,856	4,794,055
September	431,051	1,644,857	403,977	1,872,264	4,352,149
October	584,178	2,398,686	351,166	2,702,988	6,037,018
November	604,397	2,946,265	186,457	2,718,004	6,455,123
December	614,346	3,226,072	273,947	2,740,447	6,854,812
	8,677,589	21,944,985	2,967,759	40,141,391	73,631,724

1915.

January	464,627	3,395,637	233,389	2,263,157	6,356,810
February	421,922	3,477,229	102,043	2,552,509	6,553,703
March	459,546	4,169,535	93,759	2,706,095	7,428,935
April	455,184	8,092,059	238,591	2,464,989	11,250,823
May	506,786	4,209,234	190,446	2,854,497	7,762,963
June	462,224	4,866,060	306,820	2,728,038	8,363,142
July	551,222	4,407,729	408,050	3,746,459	9,113,460
August	555,514	3,712,734	378,099	3,320,413	7,966,760
September	518,546	3,799,488	431,687	3,124,428	7,874,149
October	534,608	3,197,077	550,766	3,561,007	7,843,458
November	520,012	2,932,428	901,725	3,569,701	7,923,866
December	541,437	2,830,494	983,460	5,121,783	9,477,174
	5,993,628	49,079,704	4,818,835	38,023,076	97,915,243

[a] Includes Wheeler.

1914.

Month.	Runs from wells.		Field fuel and rail shipments not included in pipe-line runs.	Total.
	Gulf, Magnolia, Prairie, and Texas companies' trunk lines.	Private and other lines supplying refineries in Oklahoma and Kansas.		
January	4,598,535	991,915	304,732	5,895,182
February	4,193,255	915,729	208,899	5,317,883
March	5,480,133	1,173,397	191,596	6,845,126
April	5,252,138	1,090,695	199,029	6,541,862
May	5,822,786	978,818	308,097	7,109,701
June	5,500,908	994,942	347,836	6,843,686
July	5,196,925	1,100,406	287,796	6,585,127
August	3,635,911	878,805	279,339	4,794,055
September	2,854,628	981,394	516,127	4,352,149
October	4,217,248	1,179,743	640,027	6,037,018
November	4,344,929	1,298,479	811,715	6,455,123
December	4,796,614	1,350,576	707,622	6,854,812
	55,894,010	12,934,899	4,802,815	73,631,724

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Petroleum marketed in Oklahoma in 1914 and 1915, in barrels—Continued.

1915.

Month.	Runs from wells.		Field fuel and rail shipments not included in pipe-line runs.	Total.
	Gulf, Magnolia, Prairie, and Texas companies' trunk lines.	Private and other lines supplying refineries in Oklahoma and Kansas.		
January	4,216,615	1,518,054	622,141	6,356,810
February	4,425,688	1,515,636	612,379	6,553,703
March	4,840,940	1,813,975	774,020	7,428,935
April	8,634,387	1,854,699	761,737	11,250,823
May	5,438,069	1,981,651	343,243	7,762,963
June	5,178,439	2,861,332	323,371	8,363,142
July	5,962,230	2,856,166	295,064	9,113,460
August	4,819,057	2,950,314	197,389	7,966,760
September	4,568,122	3,126,145	179,882	7,874,149
October	4,783,173	2,908,577	151,708	7,843,458
November	4,844,727	2,880,357	198,782	7,923,866
December	6,279,221	3,015,245	182,708	9,477,174
	63,990,668	29,282,151	4,642,424	97,915,243

GLENN POOL.

Petroleum marketed from Glenn pool, 1911–1915, in barrels.

Month.	1911	1912	1913	1914	1915
January	1,099,192	882,385	792,336	839,483	464,627
February	967,924	867,566	718,580	769,809	421,922
March	2,584,464	924,144	807,022	871,334	459,546
April	1,570,947	898,527	823,645	849,316	455,184
May	1,069,863	927,182	850,607	897,397	508,786
June	958,519	816,028	816,789	852,901	462,224
July	965,122	880,906	787,274	828,350	551,222
August	981,946	927,675	734,476	535,027	555,514
September	937,886	794,958	773,847	431,051	518,546
October	969,247	921,736	817,628	584,178	534,608
November	864,519	768,254	753,115	604,397	520,012
December	910,489	886,157	794,551	614,346	541,437
	13,880,118	10,495,518	9,469,870	8,677,589	5,993,628

OSAGE COUNTY.

Petroleum marketed in Osage County from Jan. 1, 1903, to Dec. 31, 1915, in barrels.

1903	56,905	1908	4,961,147	1913	9,009,996
1904	652,479	1909	4,516,524	1914	9,935,692
1905	3,421,478	1910	5,892,970	1915	8,604,389
1906	5,219,106	1911	11,707,676		
1907	5,143,971	1912	8,169,158		

Amount received by Osage Nation for royalty oil and gas from wells in Osage County, 1911–1915.

Year.	Oil.	Gas.	Total.	Year.	Oil.	Gas.	Total.
1911	$691,399	$3,489	$694,888	1914	$993,770	$10,252	$1,044,022
1912	677,739	3,895	681,634	1915	629,539	13,689	643,228
1913	1,033,530	5,943	1,039,473				

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The table following shows the number of wells owned in Osage County by the Indian Territory Illuminating Oil Co. and its sublessees.

Oil and gas wells in Osage County, 1903–1915.

Date.	Completed.	Productive.	Gas.	Dry.[a]	Date.	Completed.	Productive.	Gas.	Dry.[a]
Jan. 1, 1903.....	30	17	2	11	Dec. 31, 1908.....	1,422	936	78	408
Dec. 31, 1904.....	361	243	21	97	Dec. 31, 1909.....	1,574	1,027	81	466
June 10, 1905.....	544	355	34	155	Dec. 31, 1910.....	1,735	1,175	82	478
Dec. 31, 1905.....	704	462	45	197	Dec. 31, 1911.....	2,233	1,562	90	581
June 10, 1906.....	862	569	55	238	Dec. 31, 1912.....	2,682	1,887	112	683
Dec. 31, 1906.....	1,080	716	66	298	Dec. 31, 1913.....	3,307	2,323	145	839
June 30, 1907.....	1,155	779	67	309	Dec. 31, 1914.....	3,785	2,654	172	959
Dec. 31, 1907.....	1,277	837	71	369	June 30, 1916.....	4,211	2,838	227	1,146

[a] Wells that have been exhausted and abandoned in addition to wells that were dry when drilled in.

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade journal sources and differ somewhat from those on page 590, obtained from reports received directly from the oil producers:

Well record in Oklahoma in 1914 and 1915.

District and pool.	1914					1915				
	Wells completed.			Initial daily production (barrels).		Wells completed.			Initial daily production (barrels).	
	Oil.	Dry.	Total.	Total.	Average per well.	Oil.	Dry.	Total.	Total.	Average per well.
Cherokee, deep sand:										
Bartlesville, Hogshooter	389	44	454	3,925	10.1					
Copan, Ramsey, Wann	266	79	421	7,022	26.4	183	33	242	2,223	12.1
Dewey	440	33	486	5,093	11.6					
Bird Creek, Turley, Owasso, Collinsville, Vera	236	80	428	3,946	16.8	141	45	229	5,703	40.4
	1,331	236	1,789	19,986	15.0	324	78	471	7,926	24.5
Cherokee, shallow sand: Delaware, Alluwe, Chelsea	1,472	77	1,558	16,172	11.0	519	54	600	10,595	20.4
Pawnee: Cleveland	77	27	111	3,905	50.7	47	26	76	1,328	28.3
Creek:										
Bald Hill	472	104	579	40,135	85.0	197	70	275	11,110	56.4
Cushing	670	52	758	668,365	997.6	967	66	1,056	834,980	863.5
Glenn, Taneha, Sapulpa, Tulsa, Inola, Wicey, Kelleyville	872	252	1,195	56,920	65.3	413	108	575	20,934	50.7
Morris, Okmulgee	256	85	358	16,197	63.3	75	32	113	3,575	47.7
Muskogee, Wagoner, Coweta, Haskell, Broken Arrow, Okfuskee	200	139	380	7,532	32.7	318	237	623	39,077	122.9
Shulter, McIntosh	139	70	235	5,427	39.0	41	37	92	2,345	57.1
Mounds, Hamilton Switch	42	17	68	2,484	59.1	33	11	44	1,300	39.4
Miscellaneous	.....	.....	.....	.....	.....	.....	4	6	.....	.....
	2,651	719	3,573	797,060	300.7	2,044	565	2,784	913,321	446.8
Osage	423	99	572	26,787	63.3	139	31	190	15,830	113.9
Carter County	340	43	392	106,171	312.3	289	22	318	85,320	295.2
Comanche County	5	2	14	59	11.8	5	8	18	35	7.0
Hughes County	.....	.....	.....	.....	.....	1	5	6	40	40.0
Kay County	58	49	113	5,417	93.4	16	10	32	1,630	101.9
Kiowa County	33	1	36	185	5.6	.....	.....	.....	.....	.....
Marshall County	.....	.....	.....	.....	.....	2	24	37	10	5.0
Pontotoc County	10	10	26	172	17.2	1	10	23	5	5.0
Stephens County	.....	.....	.....	.....	.....	10	6	18	130	13.0
Miscellaneous	10	80	108	330	33.0	.....	46	51	.....	.....
	6,410	1,343	8,292	976,244	152.3	3,397	885	4,624	1,036,170	305.0

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Wells completed in Oklahoma, 1911–1915.

District.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Cherokee, deep	836	2,444	2,724	1,331	324	114	256	299	236	78	1,074	2,906	3,249	1,789	471
Cherokee, shallow	1,381	761	1,071	1,472	519	109	87	139	77	54	1,576	881	1,231	1,558	600
Cleveland	129	196	187	77	47	31	46	68	27	26	165	253	262	111	76
Creek	536	852	2,404	2,651	2,044	175	344	654	719	565	746	1,346	3,313	3,573	2,784
Osage	438	417	506	423	139	40	54	69	90	31	494	489	620	572	190
Carter County	.....	.....	15	340	289	.....	.....	5	43	22	.....	.....	23	392	318
Comanche County	.....	.....	.....	5	5	.....	.....	.....	2	8	.....	.....	.....	14	18
Hughes County	.....	.....	.....	.....	1	.....	.....	.....	.....	5	.....	.....	.....	.....	6
Kay County	.....	31	29	58	16	.....	20	23	49	10	.....	58	55	113	32
Kiowa County	.....	.....	.....	33	.....	.....	.....	.....	1	.....	.....	.....	.....	36	.....
Marshall County	.....	.....	.....	.....	2	.....	.....	.....	.....	24	.....	.....	.....	.....	37
Pontotoc County	.....	.....	.....	10	1	.....	.....	.....	10	10	.....	.....	.....	26	23
Stephens County	.....	.....	.....	.....	10	.....	.....	.....	.....	6	.....	.....	.....	.....	18
Miscellaneous	4	11	29	10	.....	20	36	51	80	46	32	60	98	108	51
	3,294	4,712	6,965	6,410	3,397	489	843	1,308	1,343	885	4,087	5,903	8,851	8,292	4,624

[a] Including gas wells.

Oil wells and dry holes drilled in Oklahoma in 1915.

District.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Cherokee, deep	18	8	12	3	11	3	10	4	13	1	7	2	11	3
Cherokee, shallow	50	1	35	1	38	3	29	3	23	.....	11	2	22	3
Cleveland	.....	.....	.....	.....	.....	.....	.....	.....	5	6	4	1	4	.....
Creek	122	30	146	35	127	42	178	38	165	28	188	37	145	39
Osage	10	.....	22	10	12	2	11	3	2	1	1	.....	5	.....
Carter County	7	5	2	.....	6	.....	7	3	5	.....	7	.....	14	.....
Comanche County	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hughes County	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Kay County	3	1	1	.....	.....	.....	1	.....	1	.....	.....	.....	4	.....
Marshall County	1	1	.....	1	.....	8	.....	.....	.....	.....	1	1	2	.....
Pontotoc County	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	3	.....
Stephens County	2	.....	7	.....	1	1	.....	.....	.....	.....	2	.....	.....	.....
Miscellaneous	.....	7	.....	2	.....	4	.....	3	.....	.....	.....	4	.....	.....
	213	56	225	52	195	63	236	56	214	39	219	51	205	45

District.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Cherokee, deep	16	1	14	2	51	10	64	20	97	21	324	78
Cherokee, shallow	13	5	16	1	59	13	102	11	121	11	519	54
Cleveland	2	2	.....	3	8	1	9	8	15	5	47	26
Creek	160	41	124	50	181	41	237	96	271	88	2,044	565
Osage	5	4	2	1	14	3	22	3	33	4	139	31
Carter County	20	2	20	6	47	4	59	1	95	1	289	22
Comanche County	.....	.....	.....	.....	3	1	2	4	.....	1	5	8
Hughes County	.....	1	.....	2	.....	1	.....	.....	1	.....	1	5
Kay County	.....	.....	2	4	1	1	2	3	1	1	16	10
Marshall County	.....	.....	.....	5	.....	.....	.....	6	.....	.....	2	24
Pontotoc County	.....	2	.....	.....	.....	2	.....	.....	1	1	1	10
Stephens County	.....	.....	.....	.....	.....	.....	.....	2	.....	1	10	6
Miscellaneous	.....	.....	.....	8	.....	4	.....	10	.....	4	.....	46
	216	58	178	82	364	81	497	164	635	138	3,397	885

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Wells completed in Oklahoma, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	245	135	375	684	213	30	28	69	153	56	290	180	483	876	292
February	278	289	433	653	225	16	61	61	138	52	309	366	520	849	297
March	329	288	461	733	196	27	46	67	149	63	375	361	492	929	285
April	393	388	470	725	236	56	77	46	190	56	479	508	548	974	334
May	356	386	624	796	214	56	77	111	178	39	436	501	793	1,044	275
June	265	495	664	660	219	64	86	135	116	51	364	636	885	829	285
July	225	458	647	531	205	46	70	180	101	45	313	566	884	668	263
August	217	430	691	469	216	35	62	130	81	58	275	526	864	588	287
September	240	427	626	438	178	22	70	97	72	82	301	527	775	527	322
October	222	456	656	282	364	32	97	125	44	81	275	592	830	372	485
November	294	506	669	186	497	45	100	122	52	164	367	654	846	278	711
December	230	474	709	253	635	50	69	165	69	138	303	576	931	358	828
	3,294	4,712	6,965	6,410	3,397	489	843	1,308	1,343	885	4,087	5,993	8,351	8,292	4,624

[a] Including gas wells.

Initial daily production of new wells completed in Oklahoma in 1915, in barrels.

District.	January.	February.	March.	April.	May.	June.	July.
Cherokee, deep	396	365	170	153	270	230	255
Cherokee, shallow	380	808	1,410	1,130	540	185	345
Cleveland					200	165	50
Creek	119,858	111,590	80,465	145,813	122,995	111,310	70,770
Osage	1,735	4,095	1,070	760	50	100	775
Carter County	900	300	1,950	1,450	350	1,215	3,320
Comanche County							
Hughes County							
Kay County	190	50		100	50		925
Kiowa County							
Marshall County	5					5	
Pontotoc County							
Stephens County	20	105	5				
	123,484	117,313	85,070	149,406	124,455	113,210	76,440

District.	August.	September.	October.	November.	December.	Total.
Cherokee, deep	265	605	1,157	1,805	2,255	7,926
Cherokee, shallow	140	215	1,230	2,528	1,684	10,595
Cleveland	58		185	235	435	1,328
Creek	45,465	20,525	33,495	28,080	23,005	913,321
Osage	905	80	2,970	1,690	1,600	15,820
Carter County	1,865	3,185	22,165	29,845	18,775	86,320
Comanche County			15	20		35
Hughes County					40	40
Kay County		120	25	95	75	1,630
Kiowa County						
Marshall County						10
Pontotoc County					5	5
Stephens County						130
	48,698	24,730	61,242	64,248	47,874	1,036,170

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Total and average initial daily production of new wells in Oklahoma, 1911–1915, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Cherokee, deep	30,135	76,025	67,505	19,986	7,926	37.4	31.1	24.8	15.0	24.5
Cherokee, shallow	70,221	10,930	17,672	16,172	10,595	50.8	14.3	16.5	11.0	20.4
Cleveland	22,100	33,903	15,787	3,905	1,328	171.3	173.0	84.4	50.7	28.3
Creek	49,879	77,588	193,796	797,060	913,321	93.1	91.1	80.6	300.7	446.8
Osage	89,660	25,400	34,856	26,787	15,830	204.7	60.9	68.9	63.3	113.9
Carter County	.....	.....	844	106,171	85,320	.....	.....	56.3	312.3	295.2
Comanche County	.....	.....	.....	59	35	.....	.....	.....	11.8	7.0
Hughes County	.....	.....	.....	.....	40	.....	.....	.....	.....	40.0
Kay County	.....	4,790	2,964	5,417	1,630	.....	154.5	102.2	93.4	101.9
Kiowa County	.....	.....	.....	185	.....	.....	.....	.....	5.6	.....
Marshall County	.....	.....	.....	.....	10	.....	.....	.....	.....	5.0
Pontotoc County	.....	.....	.....	172	5	.....	.....	.....	17.2	5.0
Stephens County	.....	.....	.....	.....	130	.....	.....	.....	.....	13.0
Miscellaneous	338	250	626	330	.....	84.5	22.7	21.6	33.0	.....
	262,333	228,886	334,050	976,244	1,036,170	79.6	48.6	48.0	152.3	305.0

Total initial daily production of new wells in Oklahoma, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1910..	15,840	17,785	20,915	18,932	19,545	26,378	14,915	16,680	18,998	18,585	17,915	20,150	226,638	18,887
1911..	23,366	28,615	40,539	30,440	28,190	28,970	16,255	12,121	14,709	18,165	17,223	13,740	262,333	21,861
1912..	9,448	13,807	12,281	17,329	10,993	17,617	18,507	24,635	22,096	27,519	27,599	27,055	228,886	19,074
1913..	19,220	19,505	21,615	29,847	27,139	32,192	26,071	27,897	27,267	30,953	29,211	43,133	334,050	27,838
1914..	27,786	49,344	60,201	61,233	102,674	128,886	84,552	91,886	92,453	81,357	71,488	133,285	976,244	81,354
1915..	123,484	117,313	85,070	149,406	124,455	113,210	76,440	48,698	24,730	61,242	64,248	47,874	1,036,170	86,348

GULF OIL FIELD.

GENERAL STATEMENT.

The term Gulf field as used in this report includes that portion of the Gulf Coastal Plain of Texas and Louisiana in which petroleum is found in domes, associated with rock salt and gypsum. In this area the age of the oil-bearing strata ranges from Cretaceous to Quaternary and the reservoir rock is generally either porous dolomitic limestone or sandstone.

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MARKETED PRODUCTION.

Petroleum marketed in the Gulf field in 1914 and 1915, in barrels.

Month.	1914			1915		
	Coastal Texas.	Coastal Louisiana.	Total.	Coastal Texas.	Coastal Louisiana.	Total.
January	616,115	186,094	802,209	952,926	237,295	1,190,221
February	580,324	168,039	748,363	1,152,622	270,505	1,423,127
March	831,623	236,346	1,067,969	1,194,909	273,751	1,468,660
April	1,010,514	216,827	1,227,341	1,142,964	288,017	1,430,981
May	1,042,417	214,345	1,256,762	1,024,083	223,516	1,247,599
June	1,072,371	187,418	1,259,789	1,099,397	230,525	1,329,922
July	945,745	179,269	1,125,014	1,314,212	244,508	1,558,720
August	920,260	219,088	1,139,348	1,212,738	273,428	1,486,166
September	888,436	212,768	1,101,204	1,631,357	246,323	1,877,680
October	991,078	231,086	1,222,164	2,146,220	290,972	2,437,192
November	873,616	230,875	1,104,491	2,574,892	248,679	2,823,571
December	844,063	218,811	1,062,874	2,021,278	281,986	2,303,264
	10,616,562	2,500,966	13,117,528	17,467,598	3,109,505	20,577,103
Increase, 1915:						
Barrels				6,851,036	608,539	7,459,575
Per cent				64.53	24.33	56.87

Petroleum marketed in the Gulf field, 1889–1915.

Year.	Production (barrels).	Percentage of total production.	Increase or decrease.		Value.	Yearly average price per barrel.
			Barrels.	Per cent.		
1889	48				$340	$7.084
1890	54		+ 6	+ 12.50	227	4.204
1891	54				227	4.204
1892	45		− 9	− 16.67	225	5.000
1893	50		+ 5	+ 11.11	210	4.200
1894	60		+ 10	+ 20.00	300	5.000
1895	50		− 10	− 16.67	250	5.000
1896	50				250	5.000
1897	50				250	5.000
1898	1,450		+ 1,400	+2,800.00	7,250	5.000
1899	530		− 920	− 63.45	2,650	5.000
1900	0		− 530	− 100.00		
1901	3,593,113	5.18	+ 3,593,113		630,752	.175
1902	18,014,404	20.29	+14,421,291	+ 401.36	3,766,683	.209
1903	18,371,383	18.29	+ 356,979	+ 1.98	7,418,393	.411
1904	24,631,269	21.03	+ 6,259,886	+ 34.07	8,817,454	.357
1905	36,526,323	27.11	+11,895,054	+ 48.29	8,791,983	.240
1906	20,524,162	16.23	−16,002,161	− 43.81	9,380,691	.457
1907	16,360,299	9.85	− 4,163,863	− 20.29	13,704,469	.837
1908	15,772,137	8.83	− 588,162	− 3.60	9,511,007	.603
1909	10,883,240	5.94	− 4,888,897	− 30.00	7,872,686	.723
1910	9,680,465	4.62	− 1,202,775	− 11.05	7,383,571	.763
1911	10,999,873	4.99	+ 1,319,408	+ 13.63	7,355,681	.669
1912	8,515,018	3.83	− 2,484,855	− 22.32	6,344,173	.742
1913	8,542,494	3.44	− 2,524	− .03	7,993,997	.936
1914	13,117,528	4.94	+ 4,575,034	+ 53.56	8,844,104	.674
1915	20,577,103	7.32	+ 7,459,575	+ 56.87	9,802,901	.476
	236,141,252	6.53			117,630,724	.498

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Petroleum marketed, value, and average price per barrel in the Gulf field, 1906–1915.

Year.	Coastal Texas.			Coastal Louisiana.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1906..	11,449,992	$5,825,036	$0.5087	9,074,170	$3,555,655	$0.392	20,524,162	$9,380,691	$0.457
1907..	11,410,078	9,680,286	.848	4,950,221	4,024,183	.813	16,360,299	13,704,469	.837
1908..	10,483,200	6,221,686	.593	5,288,937	3,289,371	.622	15,772,137	9,511,007	.603
1909..	8,852,527	6,399,318	.723	2,030,713	1,473,368	.725	10,883,240	7,872,686	.723
1910..	7,929,863	6,100,359	.769	1,750,602	1,283,212	.733	9,680,465	7,383,571	.763
1911..	7,275,281	5,340,592	.734	3,724,592	2,015,089	.541	10,999,873	7,355,681	.669
1912..	6,459,528	4,739,887	.734	2,085,490	1,604,286	.769	8,545,018	6,344,173	.742
1913..	5,826,226	5,550,408	.953	2,717,268	2,443,589	.899	8,542,494	7,993,997	.936
1914..	10,616,562	7,163,893	.675	2,500,966	1,680,211	.672	13,117,528	8,844,104	.674
1915..	17,467,598	8,363,591	.479	3,109,505	1,439,310	.463	20,577,103	9,802,901	.476

Petroleum marketed in the Gulf field, 1911–1915, in barrels.

Month.	1911	1912	1913	1914	1915
January	1,080,926	717,938	704,900	802,209	1,190,221
February	1,280,144	741,842	610,703	748,363	1,423,127
March	1,283,975	784,730	876,333	1,067,969	1,468,680
April	1,004,704	752,583	756,342	1,227,341	1,430,961
May	985,075	707,766	757,767	1,256,762	1,247,599
June	848,610	684,210	696,534	1,259,789	1,329,922
July	822,501	713,912	676,240	1,125,014	1,558,730
August	777,506	700,644	687,520	1,139,348	1,486,166
September	750,862	675,053	683,938	1,101,204	1,877,680
October	758,321	670,532	678,060	1,222,164	2,437,192
November	671,778	684,341	671,789	1,014,491	2,823,571
December	735,471	711,467	742,368	1,062,874	2,303,264
	10,999,873	8,545,018	8,542,494	13,117,528	20,577,103

Average daily production of petroleum in the Gulf field, 1911–1915, in barrels.

Month.	1911	1912	1913	1914	1915
January	34,869	23,159	22,739	25,878	38,394
February	45,719	25,581	21,811	26,727	50,826
March	41,419	25,314	28,269	34,451	47,376
April	33,490	25,086	25,211	40,911	47,699
May	31,777	22,831	24,445	40,541	40,245
June	28,287	22,807	23,218	41,993	44,331
July	26,532	23,029	21,814	36,291	50,281
August	25,081	22,601	22,178	36,753	47,941
September	25,029	22,502	22,798	36,707	62,589
October	24,462	21,630	21,873	39,425	78,619
November	22,393	22,811	22,393	36,816	94,119
December	23,725	22,951	23,947	34,286	74,299
Average	30,137	23,347	23,404	35,938	56,376

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PIPE-LINE RUNS, DELIVERIES, AND STOCKS.

Pipe-line runs and deliveries of petroleum from the Gulf field and stocks at end of each month in 1914 and 1915, in barrels.

Month.	1914			1915		
	Runs.	Deliveries.	Stocks.	Runs.	Deliveries.	Stocks.
Dec. 31, 1913			2,058,776			
January	802,209	946,533	1,914,452	1,190,221	887,569	4,266,396
February	748,383	596,039	2,064,776	1,423,127	1,145,393	4,544,130
March	1,067,969	695,174	2,437,571	1,468,660	1,206,890	4,805,900
April	1,227,341	816,813	2,848,099	1,430,981	1,211,077	5,025,804
May	1,256,762	963,029	3,141,832	1,247,599	1,232,686	5,040,717
June	1,259,789	666,686	3,734,935	1,329,922	1,709,332	4,661,307
July	1,125,014	1,063,036	3,796,913	1,558,720	1,295,361	4,924,666
August	1,139,348	1,104,615	3,831,646	1,486,166	1,207,877	5,202,955
September	1,101,204	1,184,335	3,748,515	1,877,680	1,653,138	5,427,497
October	1,222,164	950,706	4,019,973	2,437,192	1,764,700	6,099,989
November	1,104,491	1,023,848	4,100,616	2,823,571	2,137,371	6,786,189
December	1,062,874	1,199,746	3,963,744	2,303,264	2,067,048	7,022,405
	13,117,528	11,212,560	.....	20,577,103	17,518,442	.....

PRICES.

Average monthly prices per barrel of petroleum in the Gulf field, 1914 and 1915.

1914.

Month.	Coastal Texas.					
	Batson.	Dayton.	Goose Creek.	Humble.	Markham.	Orange County.
January	$0.85–$1.00	$0.75	$0.85	$0.85–$1.00	$0.90	$1.27
February	.85– 1.00	.75	.85	.85– 1.00	.90	1.27
March	.85– 1.00	.65	$0.70–.85	.75– .80	.75	1.27
April	.57– .97	.48	.65–.85	.50– .52	.50	1.17
May	.50– .95	.40	.50–.85	.45– .50	.50	1.17
June	.45– .92	.30	.50–.85	.40– .50	.50	1.17
July	.40– .92	.30	.45–.85	.40	.50	.74
August	.40– .92	.30	.40–.45	.40	.50	.77
September	.40– .92	.30	.40–.45	.40	.50	.77
October	.40– .91	.30	.45	.40	.50	.70
November	.40– .83	.30	.40–.45	.40	.50	.70
December	.40– .89	.30	.40–.45	.40	.50	.70
Average	.804	.469	.586	.548	.598	1.023

Month.	Coastal Texas—Continued.			Coastal Louisiana.		
	Saratoga.	Sourlake.	Spindletop.	Edgerly.	Jennings.	Vinton.
January	$0.85–$0.99	$0.85–$1.06	$0.90–$1.03	$0.90	$0.90–$1.00	$0.90–$1.00
February	.85– .98	.85– 1.02	.90– 1.03	.90	.90– 1.00	.90– 1.00
March	.80– .99	.75– .99	.85– 1.02	.89	.75– .99	.75– .99
April	.57– .99	.50– .84	.60– 1.03	.68	.50– 1.00	.50– .98
May	.50– 1.00	.47½– .79	.50– 1.02	.51	.50– 1.00	.50– .99
June	.45– 1.00	.45– .84	.45– 1.02	.50	.50– 1.00	.50– .99
July	.40– .77	.40– .79	.40– 1.04	.50	.45– 1.00	.40– .91
August	.40– .74	.40– .81	.40– 1.03	.40	.45– 1.00	.40– .99
September	.40– .70	.40– .86	.40– 1.02	.40	.45– 1.00	.40– .99
October	.40– .72	.40– .87	.40– .99	.40	.45– 1.00	.40– .99
November	.40– .69	.40– .85	.40– .99	.40	.45– 1.00	.40– .99
December	.40– .70	.40– .92	.40– .99	.40	.45– 1.00	.40– .91
Average	.727	.679	1.004	.490	.909	.671

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Average monthly prices per barrel of petroleum in the Gulf field, 1914 and 1915—Contd.

1915.

Month.	Coastal Texas.					
	Batson.	Dayton.	Goose Creek.	Humble.	Markham.	Orange County.
January	$0.40–$0.43	$0.40	$0.50	$0.40–$0.43	$0.45	$0.65
February	.40– .45	.45	.50	.40– .45	.46	.65
March	.40– .45	.45	.50	.40– .45	.50	.65
April	.40– .45	.45	.50	.40– .45	.50	.60
May	.40– .45	.45	.40	.40– .45	.50	.60
June	.40– .45	.45	.50	.40– .45	.50	.60
July	.42– .46	.46	.50	.41– .46	.50	.60
August	.50	.50	.50	.50	.50	.60
September	.50	.50	.50	.50	.50	.60
October	.50	.50	.50	.50	.50	.60
November	.50	.50	.50	.50	.50	.60
December	.53	.53	.50	.53– .54	.54	.60
Average	.403	.466	.515	.482	.510	.615

Month.	Coastal Texas—Continued.			Coastal Louisiana.		
	Saratoga.	Sourlake.	Spindletop.	Edgerly.	Jennings.	Vinton.
January	$0.40–$0.43	$0.40–$0.43	$0.43–$0.45	$0.40	$0.40–$0.45	$0.40–$0.45
February	.40– .45	.40– .45	.45	.40	.40– .45	.40– .45
March	.40– .45	.40– .45	.45	.40	.40– .45	.40– .45
April	.40– .45	.40– .45	.45	.40	.40– .45	.40– .45
May	.40– .45	.40– .45	.45	.40	.40– .45	.40– .45
June	.40– .45	.40– .45	.45	.40	.40– .45	.40– .45
July	.42– .46	.41– .46	.46– .47	.42	.42– .45	.42– .45
August	.50	.50	.50– .55	.50	.45– .50	.50– .59
September	.50	.50	.50– .55	.50	.45– .50	.50– .60
October	.50	.50	.50– .55	.50	.45– .50	.50– .60
November	.50	.50	.50– .56	.50	.45– .50	.50– .60
December	.53	.53– .54	.50– .58	.50	.50– .53	.53– .64
Average	.510	.460	.492	.452	.486	.457

Prices paid for Gulf oil per barrel in 1915 by the principal pipe-line companies, and dates on which the changes were made.

Date.	Coastal Texas.									
	Batson.		Dayton.	Goose Creek.	Humble.			Markham.	Saratoga.	
	Gulf.	Sun.	Sun.	Gulf.	Gulf.	Sun.	Texas.	Texas.	Gulf.	Sun.
1915.										
Jan. 1	$0.40	$0.40	$0.30	$0.50	$0.40	$0.40	$0.40	$0.45	$0.40	$0.40
Jan. 11	.....	.45	.45	.....	.....	.45	.....	.....	.....	.45
Feb. 19	.....	.....	.....	.....	.....	.....	.....	.50	.....	.....
May	.....	.....	.....	.40	.....	.....	.....	.....	.....	.....
July	.....	.....	.....	.50	.....	.....	.....	.....	.....	.....
July 23	.....	.50	.50	.....	.....	.50	.....	.....	.....	.50
July 26	.50	.....	.....	.....	.50	.....	.....	.....	.50	.....
July 28	.....	.....	.....	.....	.....	.....	.50	.....	.....	.....
Aug. 3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Dec. 20	.....	.....	.....	.....	.....	.....	.60	.60	.....	.....
Dec. 22	.....	.60	.60	.....	.....	.60	.....	.....	.....	.60
Dec. 23	.60	.....	.....	.....	.60	.....	.....	.....	.60	.....

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Prices paid for Gulf oil per barrel in 1915 by the principal pipe line companies, and dates on which the changes were made—Continued.

Date.	Coastal Texas—Continued.					Coastal Louisiana.					
	Sour Lake.			Spindletop.		Edgerly.	Jennings.		Vinton.		
	Gulf.	Sun.	Texas.	Gulf.	Sun.	Gulf.	Gulf.	Texas.	Gulf.	Sun.	Texas.
1915.											
Jan. 1	$0.40	$0.40	$0.40	$0.45	$0.40	$0.40	$0.40	$0.45	$0.40	$0.40	$0.45
Jan. 11	.....	.45	.....	.....	.45	.....	.....	.....	.....	.....	.....
Feb. 19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
May	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
July	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
July 23	.....	.50	.....	.....	.50	.....	.....	.....	.....	.....	.....
July 26	.50	.....	.....	.55	.....	.50	.50	.....	.50	.50	.....
July 28	.....	.....	.50	.....	.....	.....	.....	.....	.....	.....	.....
Aug. 3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.60
Dec. 20	.....	.....	.60	.....	.....	.....	.....	.55	.....	.....	.70
Dec. 22	.....	.60	.....	.....	.60	.....	.....	.....	.....	.....	.....
Dec. 23	.60	.....	.....	.65	.....	.....	.60	.....	.60	.60	.....

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade journal sources and differ somewhat from those on pages 590 and 591, obtained from reports received directly from the oil producers:

Wells completed in the Gulf field, 1911–1915.

District.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Coastal Texas	352	353	325	323	418	117	109	255	130	337	502	462	592	464	761
Coastal Louisiana	63	59	81	72	73	32	25	57	48	26	112	84	139	121	101
	415	412	406	395	491	149	134	312	178	363	614	546	731	585	862

[a] Including gas wells.

Oil wells and dry holes drilled in the Gulf field in 1915.

District.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Coastal Texas	22	11	26	4	19	17	28	31	46	32	50	58	32	42
Coastal Louisiana	2	.....	3	3	3	1	7	5	7	1	8	3	13	2
	24	11	29	7	22	18	35	36	53	33	58	61	45	44

District.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Coastal Texas	39	32	44	28	27	19	45	35	40	28	418	337
Coastal Louisiana	8	1	6	4	6	2	5	2	5	2	73	26
	47	33	50	32	33	21	50	37	45	30	491	363

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Wells completed in the Gulf field, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	26	16	31	45	24	15	8	9	5	11	41	24	42	51	35
February	35	44	30	26	29	10	9	25	8	7	46	53	56	37	36
March	29	39	43	26	22	17	8	16	13	18	46	47	60	39	40
April	30	47	42	24	35	14	15	45	21	36	44	62	90	46	71
May	31	29	26	45	53	10	14	16	14	33	41	43	46	61	86
June	58	30	40	35	58	17	14	41	12	61	76	44	84	47	120
July	40	28	48	43	45	14	9	33	24	44	51	37	81	68	90
August	24	35	43	35	47	.....	12	34	26	33	41	47	77	63	81
September	19	34	29	28	50	.....	14	22	10	32	33	48	51	39	83
October	16	40	27	25	33	9	13	22	18	21	25	53	49	43	54
November	20	43	21	34	50	9	8	17	18	37	29	51	37	53	88
December	24	27	26	29	45	5	10	32	9	30	29	37	58	38	78
	[b]415	412	406	395	491	[b]149	134	312	178	363	[b]614	546	731	585	862

[a] Including gas wells. [b] Coastal Louisiana not given by months.

Initial daily production of new wells completed in the Gulf field in 1915, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Coastal Texas	15,180	14,608	8,885	12,225	21,920	21,950	17,130	16,580	37,153	61,430	88,710	19,940	335,711
Coastal Louisiana	500	940	3,100	4,720	2,065	7,625	4,825	2,995	3,920	7,785	950	5,760	45,185
	15,680	15,548	11,985	16,945	23,985	29,575	21,955	19,575	41,073	69,215	89,660	25,700	380,896

Total and average initial daily production of new wells in the Gulf field, 1911–1915, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Coastal Texas	32,740	33,082	38,978	160,695	335,711	93.0	93.7	119.9	497.5	803.1
Coastal Louisiana	74,145	25,520	55,740	82,914	45,185	1,176.9	432.5	688.1	1,151.6	619.0
	106,885	58,602	94,718	243,609	380,896	257.6	142.2	233.3	616.7	775.8

Total initial daily production of new wells in the Gulf field, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911	5,970	5,890	2,115	6,380	1,561	3,455	2,708	935	1,355	772	619	980	[a]106,885	8,907
1912	2,670	5,660	4,679	3,885	2,030	2,575	7,475	3,313	12,045	1,170	7,779	5,291	58,602	4,884
1913	15,712	4,447	27,571	10,300	8,335	5,525	4,275	4,584	2,087	3,459	1,066	7,357	94,718	7,893
1914	10,551	7,101	31,975	40,624	16,071	23,652	26,085	13,043	28,685	15,520	17,772	12,530	243,609	20,301
1915	15,680	15,548	11,985	16,945	23,985	29,575	21,955	19,575	41,073	69,215	89,660	25,700	380,896	31,741

[a] Coastal Louisiana not given by months.

TEXAS.

GENERAL STATEMENT.

A marketed output of 24,942,701 barrels of petroleum in 1915 was sufficient to advance Texas to third place among the oil-producing States by a margin of nearly 6,000,000 barrels over Illinois, which had occupied that position without serious competition from 1907 to

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1914, inclusive. This output, which constitutes a gain of 24 per cent over that in 1914, is greater than the output credited to this State in any previous year with the exception of 1905, when the Humble pool, in Harris County, yielded more than 15,000,000 barrels from the upper sands and the entire production of the State was in excess of 28,000,000 barrels. The notable gain in production in Texas in 1915 may again be credited chiefly to Humble, this time as a consequence of the development of prolific sands found at depths of 1,200 to 1,600 feet below the zone of shallow-sand production. The discovery and partial development of two new pools in Texas in 1915, one in Palo Pinto County and the other in Williamson County, added more than 1,000,000 barrels to the output of petroleum in the State, but without the large contribution of Humble production in 1915 would have barely exceeded the total in 1914.

Of the output marketed in 1915 the salt-dome pools of southern Texas are credited with 17,467,598 barrels, an increase of 65 per cent over 1914, and the stratum fields of central and northern Texas with 7,475,103 barrels, a decrease of 40 per cent from 1914.

The average price of the salt-dome product was 48 cents a barrel and the total market value was $8,363,591, a decrease of 20 cents in average unit price, but a gain of $1,199,698 in total market value, compared with 1914. The average price of the stratum product was 62 cents a barrel in 1915, compared with 82 cents in 1914, and the total market value of the output was $4,663,334, a decrease of $3,115,621 from 1914.

The decline in prices noted are the immediate results of overproduction; excessive production in Oklahoma of petroleum high in content of gasoline and illuminating oil affected the grades of northern and central Texas; and excessive production of crude oil suitable for fuel and lubricants at Humble and of refinery residuals suitable for fuel in Oklahoma affected the grades of southern Texas.

DEVELOPMENT.

Although the report of field activity in Texas in 1915 shows an increase of 64 per cent, compared with 1914, in the number of wells completed in the salt-dome pools, it shows a decrease of 59 per cent in corresponding work in the stratum fields, which resulted in a net decrease of 12 per cent in the number of wells completed in the entire State. There were 1,069 wells completed in Texas in 1915, of which 613, or 57 per cent, produced oil. In the salt-dome division completed wells numbered 761, of which 418, or 55 per cent, yielded oil, whereas in the stratum division only 308 wells were completed, of which 195, or 63 per cent, were classed as oil wells. There were 6 gas wells and 337 dry holes reported in the former division and 22 gas wells and 91 dry holes in the latter. The comparative hazards of drilling in the two divisions are indicated by the ratios between dry holes and total completions, which in 1915 were approximately as 3 to 7 in the salt-dome pools and as 3 to 10 in the stratum fields.

The relative rewards for drilling in the two divisions are indicated in the tables showing initial production of new oil wells, which in 1915 averaged 803 barrels per well in the salt-dome division, due to exceptional gushers in the Humble pool, and 49 barrels per well in the stratum division.

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SALT-DOME DIVISION.

Humble.—From a position of secondary importance among the Coastal pools in 1914, Humble sprang to first place in 1915 as a consequence of an active and highly successful development of its deep sands, the value of which was just beginning to be realized at the end of 1914. Gusher wells, particularly on the Stevenson and Landslide leases, producing from the "deep pay" at depths of 2,900 to 3,300 feet, increased the output of this pool from an average of 26,000 barrels a day in August to 67,000 barrels a day in November and caused additional drilling in the locality, which resulted in the southward extension of the pool for fully half a mile. Late in December the completion of good wells on the Paraffine, Williams, Lee, and Sayers leases, west and southwest of the Stevenson, and on the Wheeler-Pickens lease north of it indicated that the productive limits of the deep-sand pool were yet to be determined in these directions.

Sourlake.—Production in the Sourlake field in 1915 declined 21 per cent below the output in 1914. An average price of 46 cents a barrel for this oil resulted in a decided falling off in field activity in this pool, in which drilling to the remunerative deep sands is especially expensive. A barren well completed in November on the Mowbray lease at a reported depth of 3,000 feet was disappointing to operators looking for an extension toward the northeast. An extension of nearly 2,000 feet to the northwest was demonstrated by the completion as a pumper in October of No. 1, Hardin by the Gulf Production Co.

Saratoga.—Third rank among the salt-dome pools of Texas was retained in 1915 by Saratoga, which is credited with 864,266 barrels, a decline of only 3 per cent from 1914. Inside development resulted in the completion of a number of creditable wells, but efforts to extend productive limits to the west and south were unsuccessful.

Batson.—The Batson pool, in Hardin County, retained fourth place in 1915, its output of 703,686 barrels being less by 9 per cent than the output in 1914. Development in 1915 was nominal. Considerable interest was evinced in the possibilities of prolific deep sands in this pool, but deep tests to 2,000 feet or more on the Millhome tract in the west end of the field, the King tract to the north, and the Prairie tract nearly a mile in advance to the southeast failed to justify the hopes of the drilling companies.

Spindletop.—At classic Spindletop interest centered in the deep test of the Gulf Production Co., No. 179, Gladys, located about one-third of a mile west of the present producing area. This well was completed June 7 at a total depth of 4,719 feet without having encountered any favorable indications of oil or gas. This pool is credited with an output of 388,266 barrels of oil in 1915, a decrease of 33 per cent from 1914.

Matagorda County.—The Markham pool was unusually quiet until late in the year when the Ten Strike Oil Co. brought in a 700-barrel well at 1,430 feet on a 12-acre tract subleased from the Clem Oil Co. and the Producers Oil Co. completed a 1,400-barrel well at 1,140 feet on the Hudson lease, the effects of which were to revive drilling activity on neighboring tracts and greatly to increase the December runs of the pool. The output of Markham, which includes that of

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one surviving producer in the old Big Hill pool, also in Matagorda County, was 137,841 barrels in 1915, a decrease of 16 per cent from 1914. At Big Hill unsuccessful tests were completed by the Farmers Petroleum Co. and C. C. Bowser, at about 1,200 feet on the Jones tract and at 2,700 feet on the Ryan tract. At Bay City, Esperson & Hamill completed a similar test at about 3,100 feet.

Goose Creek.—Production at Goose Creek, southern Harris County, amounted to 119,336 barrels in 1915, a decrease of 11 per cent from 1914. Interest was centered largely in tests on submerged lands in San Jacinto Bay inspired by the completion in January, as a 400-barrel oil well at a depth of about 1,650 feet of a test drilled on the De Merritt holdings by the State Land Co.

Orange County.—No additional wells were completed in the Bland pool, and production from the single active well decreased from 43,208 barrels in 1914 to 21,697 barrels in 1915. Unsuccessful tests were reported completed in Orange County in 1915 as follows:

June—Bessie Heights Oil Co., at Bessie Heights, 6 miles east of Spindletop; depth, 2,800 feet.
August—C. C. Codman and others, near Vidor; depth, 4,640 feet.
October—East Beaumont Oil & Gas Co., at Fletcher; depth, 2,600 feet.

Dayton.—The Dayton pool in Liberty County recorded no new wells in 1915. Production, which amounted to 10,378 barrels, was 45 per cent less than in 1914. On the Zeiss ranch, 7 miles southeast of Dayton, the Riverbottom Oil Co. completed a number of small oil wells at depths of 600 to 700 feet. Unsuccessful tests were reported abandoned in Liberty County in 1915, as follows:

March—J. M. Thrasher, on Babcock tract, north of Devers; depth, 1,940 feet.
April—Haschenberger and others, No. 1, on Hardin tract, 4 miles northeast of Liberty; depth, 2,200 feet.
October—Haschenberger and others, No. 2, on Hardin tract, 4 miles northeast of Liberty; depth, 2,900 feet.

San Patricio County.—In the Corpus Christi district, on the north side of Nueces Bay, to which attention was directed late in 1914 by the completion and loss of a monster gas well, the net result of operations in 1915 was negative so far as petroleum is concerned. A large number of tests were started early in 1915 in the immediate vicinity of the "blow-out," as well as in the territory for several miles to the southwest and northwest. In August gas, estimated at 5,000,000 to 8,000,000 cubic feet a day, open flow, was encountered at a reported depth of 2,020 feet in a well drilled by the Gulf Coast Oil & Gas Co. on the Kirk tract, 2 miles east of the discovery well. This well was successfully closed in, but it broke loose in September and continued flowing gas and salt water to the end of the year. Well No. 1 of the Gulf Production Co., located 1,700 feet north of the discovery well, was abandoned in September at 2,173 feet after several weeks' effort to recover lost tools. On the King ranch, near Kingville, 18 miles southwest of White Point, in Kleberg County, Benedum & Trees abandoned No. 1 in October at a reported depth of 2,800 feet.

Miscellaneous tests: Unsuccessful tests in the salt-dome division were reported abandoned in 1915, as follows:

Harris County:
February—Taylor and others at North Houston; depth, 1,000 feet.
July—J. H. Putnam, jr., No. 1, at Pierce Junction; depth, 1,000 feet.
September—J. H. Putnam, jr., No. 2, at Pierce Junction; depth, 709 feet.

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Jefferson County:
June—Calder Oil Co., at Amelia; depth, 3,000 feet.
Brazoria County:
June—Producers Oil Co., No. 2 Hogg, at West Columbia; depth, 1,800 feet.
September—Producers Oil Co., No. 1 Hogg, at West Columbia; depth 2,350 feet.
November—Producers Oil Co., No. 1 Keyser, at West Columbia; depth, 2,400 feet.
Galveston County:
September—Joint test Gulf Production Co. and Robicheaux, at High Island; depth, 2,245 feet.
Trinity County:
First Trinity Oil Co., at Robbs Hill, east of Trinity; depth, 2,200 feet.

STRATUM DIVISION.

Northern Texas.

Wichita County.—In the productive fields of Wichita County which include Electra, Burkburnett, Fowlkes, and Iowa Park, activity in 1915 was notably repressed until late in the year when the advancing petroleum market provided an incentive for operations other than those necessitated by lease requirements. At the close of the year these fields were unusually active for the winter season.

A feature of interest in the Electra district was the completion by the Corsicana Petroleum Co. in December, as a 25-barrel oil well, of No. 1 Piper, located fully a mile in advance of the existing western boundary of production. Additional interest in a possible extension of this district resulted from the completion, also in December, by the Producers Oil Co. of a 10-barrel well in its No. 87 Waggoner, located on Paradise Creek, near Vernon, Wilbarger County, about 25 miles west of Electra.

Activity at Burkburnett was slightly greater than at Electra, but was restricted largely to the development of the westward extension of the district on the Thom, Schnaree, and Ramming farms, demonstrated in 1914. No appreciable additions to the productive area were made during the year.

Clay County.—The Petrolia oil and gas field passed an uneventful year. Activity was principally confined to the development of natural gas along the western side of the proved area.

Shackelford County.—Operations in the Moran district continued fairly active throughout 1915 but with rather indifferent results. A 500-barrel well, completed by the Producers Oil Co., on the Gillespie lease in August, proved a minor extension to the southwest, and a 40-barrel well on the Terry tract, a mile and a half further to the southwest, completed the same month by the Corsicana Petroleum Co., offered evidence of a further extension in that direction.

Palo Pinto County.—One of the important results of activity in 1915 in the northern Texas region was the discovery and partial development of an oil field in the southwestern corner of Palo Pinto County, about 2 miles west of the town of Strawn. The discovery well was a wildcat test drilled by the Texas & Pacific Mining & Milling Co., a subsidiary of the Texas & Pacific Coal Co., about a mile and a half northwest of a shallow gas field that this company has had under development for some years. This well, No. 16, was completed January 14 at a depth of 835 feet and was rated as a 35-barrel well after the initial flow of gas had subsided. With the exception of one tract owned by the Swenson Land Co. all the acreage adjacent to the

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discovery well was controlled by the Texas & Pacific Coal Co., and, although tests were drilled on acreage at some distance from the well, operations to the end of 1915 had failed to reveal an extension of value beyond the limits of the holdings of these two companies. Development in the Strawn field in 1915 was confined largely to drilling of line wells by the Texas & Pacific and Swenson companies, and at the close of 1915 the field contained some 40 oil wells with a combined capacity of about 500 barrels a day distributed over a north-south belt about 2 miles long and about half a mile broad. Late in December two good gas wells were completed by the Texas & Pacific Coal Co. on the Graham tract in Stephens County, several miles to the northwest and in advance of the Strawn field.

Miscellaneous tests.—The presence of relatively small pools of oil at Strawn, Moran, and Jacksboro served to inspire an exceptional amount of wildcat activity in 1915 that included practically every county in north-central Texas within its scope. The situation of the Strawn pool, near the southwest corner of Palo Pinto County and adjacent to Stephens, Eastland, and Erath counties, inspired considerable activity in all those counties.

In Coleman County four wells were drilled and eventually abandoned by Robertson & Robertson on the Babbington ranch south of Coleman, in an attempt to develop an excellent showing of oil found in No. 1 at a reported depth of 1,080 feet.

Unsuccessful tests remote from production were reported abandoned in the northern Texas districts as follows:

Archer County:
January—B. W. Owens, on fee; depth, 620 feet. Guffey Petroleum Co. on the Wilson farm; depth, 638 feet.
February—Henry Ford, on fee; depth, 700 feet.
Knox County:
November—Resurrection Oil Co., on the Kaufman ranch, near Goree; depth, 2,195 feet.
Throckmorton County:
August—Swenson Land Co., on fee; depth, 2,000 feet.
Grayson County:
November—W. B. Munson and others, on the Blackford farm, near Denison; depth, 1,600 feet.
Montague County:
May—S. D. Felt and others, on Benton farm, near Nacona; depth, 380 feet.
November—C. B. Shaffer, on Jameson farm, north of Montague; depth, 2,365 feet.

Northeastern Texas.

Developments in 1915 in Marion and Cass counties, across the State boundary from the Caddo district, La., were without notable incident. The westward extension of the Monterey pool, in the Caddo district, nearly to the Texas line caused an increase in activity in northern Marion County in October and November.

Near Mineola, in Wood County, attempts to develop production from the showing of oil discovered late in 1914 were unsuccessful, and the well, which was located on the Horace Hoard farm, 7 miles east of Mineola, was abandoned in June, 1915, at a reported depth of 3,591 feet.

Near Sabinetown, Sabine County, the Corsicana Petroleum Co. completed an unsuccessful wildcat well in December at a reported depth of 2,500 feet.

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Central Texas.

Navarro County.—In the Corsicana and Powell fields of Navarro County activity was slight and no development of consequence was reported.

Williamson County.—The principal event of interest in the central Texas district in 1915 was the discovery and development of a small pool of oil near Thrall, Williamson County. The discovery well, drilled as a wildcat test by the First Thrall Oil Co., was completed February 21, at a depth of about 820 feet, on the farm of Fritz Fuchs, about 2 miles south of the town of Thrall, and was rated as a 250-barrel producer. The oil closely resembled the Corsicana light grade, being dark green by reflected light, having a gravity of about 40° B. when fresh, and containing a relatively high percentage of paraffin.

The shallow depth of the "pay sand" and the low cost of drilling, together with the size of the wells obtained—as much as 3,000 barrels of initial flow—resulted in a rapid development of the pool, which proved to lie mainly north of the discovery well and to occupy an area roughly 1½ miles north and south by a mile east and west. To the end of 1915 a total of 112 successful oil wells had been drilled in this pool, the combined initial production of which was 43,170 barrels, an average of 385 barrels for each well.

The accumulation of petroleum in this field in porous rock of igneous origin occurring in a succession of impervious shales and marls near the top of the Upper Cretaceous series is unique, no similar occurrence of oil being known in the United States.

The discovery of this field remote from other areas of oil production started a wave of exploration work that spread to all the immediately surrounding counties and stimulated wildcatting throughout the Coastal Plain area from the Louisiana boundary to the Rio Grande.

Washington County.—One result of the wildcat campaign just referred to was the discovery in October of oil at depths of 1,340 and 1,420 feet in well No. 1 of the Brenham Oil & Gas Co., on the Schuerenberg farm, 8 miles south of Brenham, Washington County. Additional tests completed before the end of 1915 confirmed this discovery but failed to show that oil is present in more than small quantities or that the area of production will be large.

A partial list of the unsuccessful tests abandoned in the central Texas district in 1915 includes the following:

McLennan County:
- November—McLennan County Oil & Gas Co., No. 1 Lane, 16 miles south of Waco; depth, 1,200 feet.
- December—Charlie Newton Oil Co., No. 1 Grimm; depth, 1,250 feet.

Falls County:
- December—Baileyville Oil & Gas Co., No. 1 Masters, 8 miles south of Lott; depth, 1,500 feet. Carnation Oil Co., No. 1 Westbrook, near Laguna; depth, 1,500 feet.

Bell County:
- September—Ferguson and others, No. 1 Warwick; depth, 1,100 feet.
- November—Thrall City Oil Co., No. 1 Hendrez; depth, 1,500 feet. Southern Oil & Gas Co., No. 1 Moore, southeast of Rogers; depth, 1,200 feet.

Milam County:
- May—Rockdale Oil & Gas Co., No. 1 Doss, at Rockdale; depth, 1,500 feet.
- July—Smith Oil Co., No. 1 Clark, near Rockdale; depth, 1,850 feet. Large Oil Co., No. 1 Davis, near Rockdale; depth, 1,820 feet.
- October—Milam County Oil & Gas Co., on Southern farm; depth, 1,500 feet.
- December—Logan and others, near Baileyville; depth, 1,025 feet. Henderson and others, No. 1 Watt, 5 miles west of Cameron; depth, 1,000 feet.

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Burleson County:
July—Bartlett Oil Co., No. 1 Strew, 3 miles east of Caldwell; depth, 1,600 feet. Caldwell Development Co., No. 1 Brooks, 6 miles east of Caldwell; depth, 1,700 feet.
December—Chriesman Independent Oil Co., No. 1 Tabor, 3 miles north of Chriesman; depth, 1,600 feet.
Lee County:
July—Noble Oil Co., on Noble ranch, near Lexington; depth, 1,200 feet.
December—John McClurkin, No. 1 Freede, 7 miles west of Lexington; depth, 1,400 feet. Austin—Lexington Oil Co., No. 1 Kube, near Lexington; depth, 1,600 feet.
Travis County:
July—F. C. Ufer and others, No. 1 Walling, near Littig; depth, 1,275 feet. F. C. Ufer and others, No. 1 Henning; depth, 1,050 feet.
Bastrop County:
July—Lexington Petroleum Co., No. 1 Wright; depth, 1,400 feet. J. M. Guffey Petroleum Co., No. 1 Kennedy, east of Elgin; depth, 1,100 feet. Mayflower Oil Co., No. 1 Campbell; depth, 1,500 feet.
August—Bastrop-Waco Oil Co., No. 1 Holbert, at Bastrop; depth, 600 feet. Simons and others, at Lathon; depth, 700 feet.
September—Hoffman & Newton, No. 1 Koch, 4½ miles south of Smithville; depth, 1,550 feet. Lomas Oil Co., 5 miles east of Smithville; depth, 1,350 feet.
Madison County:
November—Normangee Oil Co., No. 1 Hibbert, 2½ miles east of Normangee; depth, 1,500 feet. Love and others, No. 1 Wooley; depth, 1,200 feet.
Polk County:
September—Freeman and others, near Leggett; depth, 1,250 feet.
Montgomery County:
December—National Refining Co. and John O'Neill, near Security; depth, 3,800 feet.
Bee County:
November—Hindman Bros., near Skidmore; depth, 1,500 feet.

Southern Texas.

Bexar County.—Considerable interest was aroused in Bexar County in the closing months of 1915 by the completion, on September 2, of an oil well rated at 60 barrels on the Kelso farm, 8 miles south of San Antonio. The well was drilled by J. T. Marrs and associates and was completed at a depth of 1,090 feet. The oil from this field is described as black in color, about 12.5° B. in gravity, and of asphalt base. At the end of the year the field had a total of 4 producing wells and a proved area of about 10 acres adjacent to the discovery well.

Miscellaneous tests.—The following list of unsuccessful tests includes the more important wildcat tests abandoned in the stratum division of the Coastal Plain of southern Texas in 1915:

Fort Bend County:
April—Brown & Allen, No. 1 Scott & Blakely, at Blue Ridge; depth, 2,000 feet.
Wharton County:
July—Webb and others, 8 miles south of El Campo; depth, 960 feet. El Campo Oil Co. (Cherry and others), 8 miles south of El Campo; depth, 1,500 feet.
Victoria County:
July—Hancock & Crowe, 4 miles northeast of Victoria; depth, 1,900 feet.
Webb County:
December—Producers Oil Co., No. 1 Bruni; depth, 1,500 feet.

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MARKETED PRODUCTION.

Petroleum marketed in Texas, 1906–1915, in barrels.

Year.	Northern Texas.									Coastal Texas.		
	Corsicana.	Petrolia (Henrietta).	Powell.	Marion County.	Wichita County.	Moran.	Thrall.	Other.	Total.	Batson.	Dayton.	Goose Creek.
1906	332,622	111,072	673,221	.....	.....	.....	.....	990	1,117,905	2,289,507	92,850	.....
1907	226,311	83,260	596,897	.....	.....	.....	.....	6,150	912,618	2,164,453	108,038	.....
1908	211,117	85,963	421,659	.....	.....	.....	.....	4,525	723,264	1,593,570	39,901	.....
1909	180,764	113,485	383,137	.....	.....	.....	.....	4,554	681,940	1,206,214	17,647	.....
1910	137,331	126,531	450,188	251,717	.....	.....	.....	3,636	969,403	1,113,767	9,582	.....
1911	128,526	168,965	373,055	677,689	899,579	.....	.....	3,379	2,251,193	1,023,493	4,344	.....
1912	233,282	197,421	251,240	362,870	4,227,104	.....	.....	3,612	5,275,529	844,563	12,151	43,898
1913	158,830	344,868	282,476	262,392	8,131,624	.....	.....	4,062	9,184,252	741,350	13,329	249,641
1914	133,811	550,585	282,279	180,584	8,227,968	68,191	.....	8,204	9,451,622	775,804	18,791	134,748
1915	143,275	349,857	237,410	123,464	5,833,951	109,016	613,182	64,948	7,475,103	703,686	10,378	119,336

Year.	Coastal Texas—Continued.								Total.
	Humble.	Matagorda County.	Orange County.	Saratoga.	Sourlake.	Spindletop.	Other.	Total.	
1906	3,571,445	3,600	.....	2,182,057	2,156,010	1,077,492	77,031	11,449,992	12,567,897
1907	2,929,640	1,573	.....	2,130,928	2,353,940	1,699,943	21,563	11,410,078	12,322,696
1908	3,778,521	62,640	.....	1,634,786	1,595,060	1,747,537	31,185	10,483,200	11,206,464
1909	3,237,060	29,103	.....	1,183,559	1,703,798	1,388,107	87,039	8,852,527	9,534,467
1910	2,495,511	455,999	.....	1,024,348	1,518,723	1,182,436	129,497	7,929,863	8,899,266
1911	2,426,220	561,828	.....	925,777	1,364,880	965,939	2,800	7,275,281	9,526,474
1912	1,829,923	613,292	.....	1,116,655	1,175,108	822,916	1,022	6,459,528	11,735,057
1913	1,504,880	294,553	17,706	937,720	1,348,053	716,374	1,620	5,825,226	15,009,478
1914	2,799,458	164,192	43,208	889,743	5,209,208	580,130	1,280	10,616,562	20,068,184
1915	11,061,802	137,841	21,697	864,266	4,114,622	388,266	45,704	17,467,598	24,942,701

Petroleum marketed in Texas, 1906–1915.

Year.	Northern Texas.		Coastal Texas.		Total.	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1906	1,117,905	$740,542	11,449,992	$5,825,036	12,567,897	$6,565,578
1907	912,618	721,577	11,410,078	9,680,286	12,322,696	10,401,863
1908	723,264	479,072	10,483,200	6,221,636	11,206,464	6,700,708
1909	681,940	393,732	8,852,527	6,399,318	9,534,467	6,793,050
1910	969,403	505,396	7,929,863	6,100,359	8,899,266	6,605,755
1911	2,251,193	1,213,960	7,275,281	5,340,592	9,526,474	6,554,552
1912	5,275,529	4,112,826	6,459,528	4,739,887	11,735,057	8,852,713
1913	9,184,252	9,125,185	5,825,226	5,550,408	15,009,478	14,675,593
1914	9,451,622	7,778,955	10,616,562	7,163,393	20,068,184	14,942,848
1915	7,475,103	4,663,334	17,467,598	8,363,591	24,942,701	13,026,925

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Petroleum marketed in Texas in 1914 and 1915, by districts, with increase or decrease.

District.	1914			1915			Increase or decrease.	
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Barrels.	Per cent.
Northern Texas:								
Corsicana	133,811	$123,556	$0.923	143,275	$106,582	$0.744	+ 9,464	+ 7.07
Petrolia	550,585	465,628	.846	349,857	220,955	.632	− 200,728	− 36.46
Powell	282,279	169,490	.600	237,410	106,552	.449	− 44,869	− 15.90
Wichita County	8,227,968	6,789,359	.825	5,833,951	3,662,794	.628	−2,394,017	− 29.10
Marion County	180,584	175,922	.974	123,464	88,079	.713	− 57,120	− 31.63
Moran	68,191	47,081	.690	109,016	78,147	.717	+ 40,825	+ 59.87
Thrall	.....	.....	.....	613,182	345,482	.563	+ 613,182	.....
Other	8,204	7,919	.965	64,948	54,743	.843	+ 56,744	+ 691.66
	9,451,622	7,778,955	.823	7,475,103	4,663,334	.624	−1,976,519	− 40.05
Coastal Texas:								
Batson	775,804	632,926	.804	703,686	323,875	.403	− 72,118	− 9.30
Dayton	18,791	8,813	.469	10,378	4,841	.466	− 8,413	− 44.77
Goose Creek	134,748	79,012	.586	119,336	61,508	.515	− 15,412	− 11.44
Humble	2,799,458	1,535,468	.548	11,061,802	5,329,055	.482	+8,262,344	+ 295.14
Matagorda County	164,192	98,203	.598	137,841	70,300	.510	− 26,351	− 16.05
Orange County	43,208	44,223	1.023	21,697	13,351	.615	− 21,511	− 49.78
Saratoga	889,743	647,075	.727	864,266	440,409	.510	− 25,477	− 2.86
Sourlake	5,209,208	3,534,720	.679	4,114,622	1,894,403	.460	−1,094,586	− 21.01
Spindletop	580,130	582,388	1.004	388,266	191,134	.492	− 191,864	− 33.07
Other	1,280	1,065	.832	45,704	34,715	.759	+ 44,424	+3,470.63
	10,616,562	7,163,893	.675	17,467,598	8,363,591	.478	+6,851,036	+ 64.53
Total Texas	20,068,184	14,942,848	.745	24,942,701	13,026,925	.522	+4,874,517	+ 24.29

Petroleum marketed in Texas in 1914 and 1915, in barrels.

1914.

Month.	Northern Texas.								Coastal Texas.	
	Corsicana.	Petrolia (Henrietta).	Powell.	Wichita County.	Marion County.	Moran.	Other.[a]	Total.	Batson.	Goose Creek.
January	10,621	50,125	26,719	775,144	19,317	4,928	683	887,537	66,682	8,095
February	9,764	55,372	21,408	705,069	16,604	2,885	683	811,785	55,299	10,457
March	11,255	59,044	24,744	782,101	17,025	.....	683	894,852	63,627	15,585
April	10,059	44,527	23,369	752,047	15,618	4,056	683	850,359	62,089	15,324
May	9,945	47,335	22,634	737,281	14,640	4,046	684	836,565	67,928	14,196
June	10,905	42,257	23,988	696,772	13,648	4,404	684	792,658	69,483	15,827
July	10,587	40,331	23,420	683,536	13,018	3,547	684	775,123	64,961	13,452
August	11,379	40,121	23,390	680,734	15,136	3,668	684	775,112	64,831	9,366
September	10,656	37,631	23,351	636,373	15,846	8,574	684	733,115	64,211	9,611
October	16,791	38,942	23,639	625,407	14,855	9,250	684	729,568	65,152	7,530
November	11,540	47,380	22,895	585,350	12,475	12,277	684	692,601	66,430	7,650
December	10,309	47,520	22,722	568,154	12,402	10,556	684	672,347	65,041	7,655
	133,811	550,585	282,279	8,227,968	180,584	68,191	8,204	9,451,622	775,804	134,748

[a] Includes Archer, Coleman, McLennan, and McMullen counties.

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Petroleum marketed in Texas in 1914 and 1915, in barrels—Continued.

Month.	Coastal Texas—Continued.							Total.
	Humble.	Matagorda County.[a]	Orange County.	Saratoga.	Sourlake.	Spindletop.	Other.[b]	Total.	
January	208,330	16,342	3,770	78,282	182,762	49,292	2,560	616,115	1,503,652
February	186,181	14,254	3,716	63,155	199,787	45,712	1,763	580,324	1,392,109
March	309,244	15,342	5,377	74,823	297,764	47,873	1,988	831,623	1,726,475
April	310,368	15,991	4,422	75,193	477,150	47,138	2,839	1,010,514	1,860,873
May	291,057	13,063	3,921	69,012	532,184	49,075	1,961	1,042,417	1,878,982
June	273,153	15,042	3,607	69,680	573,409	49,950	2,220	1,072,371	1,865,029
July	245,233	13,708	3,745	74,066	479,428	49,852	1,280	945,745	1,720,868
August	232,694	13,213	3,301	82,160	464,357	48,731	1,557	920,260	1,695,372
September	206,317	12,550	3,011	80,787	463,050	47,856	1,043	888,436	1,621,551
October	189,754	12,205	2,876	75,091	587,617	50,281	572	991,078	1,720,646
November	172,540	11,388	2,441	74,916	489,488	47,579	1,184	873,616	1,566,217
December	174,587	11,074	3,021	72,578	462,212	46,791	1,104	844,063	1,516,410
	2,799,458	164,192	43,208	889,743	5,209,208	580,130	20,071	10,616,562	20,068,184

[a] Markham and Big Hill.
[b] Includes Duval and Nacogdoches counties and Dayton.

1915.

Month.	Northern Texas.								Coastal Texas.	
	Corsicana.	Petrolia (Henrietta).	Powell.	Wichita County.	Marion County.	Moran.	Thrall.	Other.[a]	Total.	Batson.	Dayton.
January	12,805	26,754	22,486	555,889	11,074	7,630	.....	1,155	637,793	63,587	838
February	12,356	25,120	21,390	496,407	12,157	5,961	.....	1,155	574,546	56,329	1,720
March	12,142	32,453	21,504	534,608	11,888	7,239	2,157	1,155	623,146	60,624	996
April	11,247	30,896	21,636	502,221	11,009	5,420	94,071	1,155	677,655	62,735	1,363
May	12,351	34,392	20,983	504,839	11,597	6,407	116,431	7,495	714,495	62,597	767
June	11,904	29,205	20,478	473,932	10,724	5,426	114,269	9,003	674,941	59,277	580
July	11,948	31,877	19,871	480,997	10,985	5,555	73,613	9,230	644,076	59,685	259
August	10,379	28,144	17,546	474,717	9,866	12,812	60,297	7,569	621,330	52,814	535
September	11,158	26,903	18,648	449,395	9,193	15,095	47,504	6,143	584,039	53,682	686
October	10,685	27,484	16,650	456,524	8,684	13,313	42,627	7,526	583,493	62,121	1,060
November	14,586	28,015	18,102	439,736	8,092	12,034	35,321	6,581	562,467	55,345	855
December	11,714	28,614	18,116	464,686	8,195	12,124	26,892	6,781	577,122	54,890	429
	143,275	349,857	237,410	5,833,951	123,464	109,016	613,182	64,948	7,475,103	703,686	10,378

Month.	Coastal Texas—Continued.								Total.
	Goose Creek.	Humble.	Matagorda County.[b]	Orange County.	Saratoga.	Sourlake.	Spindletop.	Other.[c]	Total.	
January	12,464	344,694	11,844	2,239	75,342	402,311	39,617	.....	952,936	1,590,719
February	10,033	615,122	10,356	2,266	73,419	346,566	36,811	.....	1,152,622	1,727,168
March	13,579	620,966	11,244	2,163	78,458	370,284	36,595	.....	1,194,909	1,818,055
April	9,799	590,914	12,574	2,273	75,656	349,043	38,607	.....	1,142,964	1,820,619
May	10,188	470,514	10,767	2,263	73,697	358,821	34,469	.....	1,024,083	1,738,578
June	9,568	585,813	13,302	1,198	75,149	323,479	31,031	.....	1,099,397	1,774,338
July	10,253	786,457	12,275	1,379	79,390	334,140	30,374	.....	1,314,212	1,958,288
August	5,318	784,374	7,541	1,790	65,900	265,616	24,750	3,800	1,212,738	1,834,068
September	8,587	1,149,746	9,302	1,617	68,829	305,977	26,751	6,180	1,631,357	2,215,396
October	11,096	1,612,448	11,993	1,848	67,752	338,734	30,508	8,660	2,146,220	2,729,713
November	7,507	2,067,268	9,513	817	66,084	326,296	29,279	11,928	2,574,892	3,137,359
December	10,944	1,433,486	17,130	1,844	64,590	393,355	29,474	15,136	2,021,278	2,598,400
	119,336	11,061,802	137,841	21,697	864,266	4,114,622	388,266	45,704	17,467,598	24,942,701

[a] Includes Archer, Jack, McLennan, McMullen, and Nacogdoches counties and Strawn.
[b] Markham and Big Hill.
[c] Includes Bexar, Duval, and Washington counties.

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RAILROAD SHIPMENTS.

Petroleum shipped by railroad in tank cars from stations in Texas, 1914 and 1915, in barrels.

1914.

Month.	Electra.	Iowa Park.	Petrolia.	Beaumont, Guffey.	Corsicana.	Markham, Noledo, Somerset.	Houston (Trice).	Humble.	Sourlake.	Total.
January	106,122	11,175	10,198	10,281	28,568	2,750	64,791	10,559	14,210	258,654
February	73,759	8,545	10,021	9,513	17,357	2,159	93,892	18,468	.....	233,714
March	58,978	7,923	11,563	11,894	9,946	3,250	122,614	32,583	.....	258,751
April	56,449	7,964	12,912	18,923	16,641	3,681	105,970	65,446	.....	287,986
May	39,971	6,807	8,287	86,368	60,773	6,421	89,324	28,279	1,525	327,755
June	5,992	5,781	7,324	35,981	93,857	6,976	61,311	18,016	463	235,701
July	9,294	5,011	8,454	26,933	45,717	10,933	74,233	25,359	18,915	224,849
August	2,497	4,624	6,924	70,038	58,655	7,157	74,794	25,562	32,169	282,420
September	25,476	4,385	7,901	68,411	83,374	6,576	71,544	30,772	67,443	365,882
October	29,668	3,740	3,661	36,164	93,467	3,798	59,988	33,200	72,875	336,561
November	17,462	3,662	.....	15,281	75,211	3,752	41,578	38,685	39,272	234,903
December	578	3,276	.....	14,783	50,963	3,636	49,596	37,136	19,058	179,026
	426,246	72,893	87,245	404,570	634,529	61,089	909,635	364,065	265,930	3,226,202

1915.

Month.	Electra, Iowa Park, Petrolia.	Beaumont, Guffey.	Corsicana.	Markham, Noledo, Somerset.	Houston (Trice).	Humble.	Saratoga.	Sourlake.	Strawn.	Total.
January	3,342	14,539	16,066	3,289	39,249	39,176	.....	27,311	.....	142,972
February	2,864	17,045	6,885	4,321	39,781	41,360	.....	46,632	.....	158,888
March	4,537	5,593	.....	4,408	41,000	24,450	235	35,398	.....	115,621
April	2,626	8,970	5,547	6,420	41,233	17,996	470	45,688	378	129,328
May	1,194	20,740	6,503	6,712	46,651	9,814	200	20,716	8,752	121,282
June	2,885	8,612	9,563	5,456	98,522	15,546	235	18,017	7,926	166,742
July	16,950	5,254	13,150	3,483	113,282	14,716	470	16,169	9,033	192,507
August	50,135	12,767	12,432	3,519	86,017	7,639	224	14,212	7,884	194,829
September	38,388	13,505	11,093	4,929	85,148	19,823	673	19,019	6,636	199,214
October	42,146	12,303	10,519	4,209	80,252	27,426	673	23,209	6,755	207,492
November	55,641	16,961	13,006	5,259	73,371	12,559	226	21,205	7,732	205,960
December	39,899	18,441	15,492	9,752	70,823	2,018	251	24,038	6,491	187,205
	260,587	154,730	120,256	61,757	815,329	232,523	3,657	311,614	61,587	2,022,040

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the following tables are compiled from trade journal sources, and differ somewhat from those on pages 590 and 591, obtained from reports received directly from the oil producers:

Wells completed in northern Texas, 1911–1915.

District.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Corsicana[b]	20	17	3	10	1	19	7	1	5	.....	39	24	4	15	1
Jack County	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
Marion County	6	3	16	8	13	9	7	6	2	5	15	10	22	10	18
Moran	.....	.....	1	3	9	.....	.....	4	3	12	.....	.....	6	12	21
Palo Pinto County	.....	.....	.....	.....	40	.....	.....	.....	.....	35	.....	.....	.....	.....	89
Petrolia[c]	7	6	122	80	4	9	10	45	32	1	19	20	171	128	8
Wichita County	51	259	435	394	124	1	66	125	169	29	53	326	561	567	156
Wilbarger County	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Young County	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Other	.....	14	4	2	.....	.....	34	27	10	9	.....	54	35	14	11
	84	299	581	497	195	38	124	208	221	91	126	434	799	744	308
Coastal Texas	352	353	325	323	418	117	109	255	130	337	502	462	592	464	761
Total Texas	436	652	906	820	613	155	233	463	351	428	628	896	1,391	1,208	1,069

[a] Including gas wells. [b] Including Powell. [c] Including Henrietta.

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Oil wells and dry holes drilled in northern Texas in 1915.

District.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Corsicana [a]	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Jack County	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Marion County	2	.....	2	.....	2	1	.....	.....	1	.....	.....	1	1	.....
Moran	.....	.....	2	1	1	1	2	1	.....	.....	.....	.....	.....	3
Palo Pinto County	1	.....	3	.....	3	.....	5	.....	8	6	3	3	2	2
Petrolia [b]	.....	.....	.....	1	1	.....	.....	.....	1	.....	.....	.....	.....	.....
Wichita County	10	4	14	6	11	3	13	3	5	3	7	1	2	.....
Wilbarger County	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Young	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....
Other	.....	2	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	14	6	21	9	18	5	21	4	15	9	10	5	5	5
Coastal Texas	22	11	26	4	19	17	28	31	46	32	50	58	32	42
Total Texas	36	17	47	13	37	22	49	35	61	41	60	63	37	47

District.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Corsicana [a]	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Jack County	.....	.....	1	.....	.....	.....	1	.....	.....	.....	2	.....
Marion County	3	.....	.....	1	.....	2	2	.....	.....	.....	13	5
Moran	2	1	1	.....	.....	.....	1	1	.....	4	9	12
Palo Pinto County	4	5	6	8	1	3	2	3	2	5	40	35
Petrolia [b]	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	4	1
Wichita County	7	.....	3	1	11	2	17	2	24	4	124	29
Wilbarger County	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	.....
Young	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Other	.....	1	.....	.....	.....	1	.....	3	.....	1	.....	9
	16	7	11	10	12	8	25	9	27	14	195	91
Coastal Texas	39	32	44	28	27	19	45	35	40	28	418	337
Total Texas	55	39	55	38	39	27	70	44	67	42	613	428

[a] Including Powell. [b] Including Henrietta.

Wells completed in northern Texas, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	2	4	38	64	14	7	.....	27	24	6	9	4	66	89	20
February	7	21	31	49	21	8	3	25	23	9	15	24	57	74	30
March	4	22	35	95	18	5	8	12	39	5	10	31	47	138	24
April	13	33	55	79	21	8	8	16	22	4	22	44	73	106	27
May	1	38	57	46	15	2	11	18	26	9	3	49	76	73	25
June	.....	12	61	44	10	.....	19	19	14	5	.....	31	80	60	17
July	7	20	47	23	5	2	12	17	18	5	10	32	66	42	14
August	3	34	56	29	16	3	18	20	11	7	6	53	77	42	24
September	9	22	41	16	11	.....	8	9	6	10	9	32	50	25	21
October	7	44	48	20	12	.....	10	10	18	8	7	55	59	40	22
November	12	22	68	22	25	1	19	25	12	9	14	42	93	36	40
December	19	27	44	10	27	2	8	10	8	14	21	37	55	19	44
	84	299	581	497	195	38	124	208	221	91	126	434	799	744	308

[a] Including gas wells.

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Initial daily production of new wells completed in northern Texas in 1915, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Corsicana [a]	2												2
Jack County									10		5		15
Marion County	110	85	90		50		600	350			160		1,445
Moran		60	75	85				165	500		110		995
Palo Pinto County	40	245	250	70	200	60	100	70	115	5	45	45	1,245
Petrolia [b]			50		200						23		273
Wichita County	355	760	285	458	215	570	100	370	75	380	795	1,125	5,488
Wilbarger County												10	10
Young County				20									20
	507	1,150	750	633	665	630	800	955	700	385	1,138	1,180	9,493
Coastal Texas	15,180	14,608	8,885	12,225	21,920	21,950	17,130	16,580	37,153	61,430	88,710	19,940	335,711
Total Texas	15,687	15,758	9,635	12,858	22,585	22,580	17,930	17,535	37,853	61,815	89,848	21,120	345,204

[a] Includes Powell. [b] Includes Henrietta.

Total and average initial daily production of new wells in northern Texas, 1911–1915, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Corsicana [a]	107	108	12	23	2	5.4	6.4	4.0	2.3	2.0
Jack County					15					7.5
Marion County	3,454	198	5,250	390	1,445	575.7	66.0	328.1	48.8	111.2
Moran			200	690	995			40.0	210.0	110.6
Palo Pinto County					1,245					31.1
Petrolia [b]	69	315	2,676	1,958	273	9.9	52.5	21.9	24.5	68.3
Wichita County	15,550	26,932	49,286	21,917	5,488	304.9	104.0	113.3	55.6	44.3
Wilbarger County					10					10.0
Young County					20					20.0
Other		660	11	25			47.1	2.2	12.5	
	19,180	28,213	57,435	25,003	9,493	228.3	94.3	98.9	50.3	48.7
Coastal Texas	32,740	33,082	38,978	160,695	335,711	93.0	93.7	119.9	497.5	803.1
Total Texas	51,920	61,295	96,413	185,698	345,204	119.1	94.0	106.4	226.4	563.1

[a] Including Powell. [b] Including Henrietta.

Total initial daily production of new wells in northern Texas, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911	4	3,265	12	567	200		428	450	2,300	2,209	5,250	4,495	19,180	1,598
1912	650	3,395	3,185	2,004	2,955	955	1,909	2,462	2,250	5,006	1,678	1,764	28,213	2,351
1913	2,726	3,366	2,986	1,909	6,258	9,720	7,391	4,593	5,605	5,092	5,291	2,498	57,435	4,786
1914	5,401	4,217	3,785	2,731	2,306	2,229	965	1,133	1,184	261	622	164	25,003	2,084
1915	507	1,150	750	633	665	630	800	955	700	385	1,138	1,180	9,493	791

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Wells completed in coastal Texas, 1911–1915.

District.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Batson	23	23	51	51	36	10	7	16	9	7	36	30	69	60	43
Bexar County	.....	.....	.....	.....	5	.....	.....	.....	.....	1	.....	.....	.....	.....	6
Dayton	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....
Duval County	.....	.....	.....	.....	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
Goose Creek	1	17	27	34	6	4	9	24	10	5	5	26	51	44	11
Humble	122	90	89	46	106	40	27	54	33	69	170	117	144	80	176
Liberty County	.....	.....	.....	.....	1	.....	.....	.....	.....	7	.....	.....	.....	.....	8
Markham	27	31	8	1	8	9	17	13	.....	.....	41	48	21	4	8
Orange County	.....	.....	.....	3	.....	.....	.....	.....	5	5	.....	.....	.....	8	5
Saratoga	45	91	49	17	34	10	11	28	4	11	56	102	78	21	45
Sourlake	76	54	64	140	93	21	8	18	44	52	101	62	85	184	146
Spindletop	58	47	29	24	11	23	30	40	7	3	93	77	69	32	14
Washington County	.....	.....	.....	.....	2	.....	.....	.....	.....	1	.....	.....	.....	.....	4
Williamson County	.....	.....	.....	.....	112	.....	.....	.....	.....	103	.....	.....	.....	.....	216
Wilson County	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	.....	.....	.....	2
Miscellaneous	.....	.....	8	5	.....	.....	.....	62	18	72	.....	.....	75	29	74
Northern Texas	352	353	325	323	418	117	109	255	130	337	502	462	592	464	761
	84	299	581	497	195	38	124	208	221	91	126	434	799	744	308
Total Texas	436	652	906	820	613	155	233	463	351	428	628	896	1,391	1,208	1,069

[a] Including gas wells.

Oil wells and dry holes drilled in coastal Texas in 1915.

District.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Batson	2	.....	2	.....	3	1	3	1	3	.....	3	.....	3	1
Bexar County	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Duval County	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1	.....	.....	.....
Goose Creek	1	.....	.....	.....	.....	.....	.....	1	.....	2	2	.....	1	.....
Humble	2	6	6	1	5	5	1	4	5	4	9	10	10	8
Liberty County	.....	.....	.....	.....	.....	1	.....	2	.....	.....	.....	.....	.....	2
Markham	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	1	.....	1	.....
Orange County	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1	.....	1
Saratoga	3	.....	2	.....	2	.....	2	2	3	1	3	1	3	1
Sourlake	12	5	14	3	6	7	8	4	12	2	11	12	7	4
Spindletop	2	.....	1	.....	.....	.....	.....	.....	1	.....	.....	1	.....	1
Washington County	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Williamson County	.....	.....	1	.....	2	2	13	13	22	19	20	26	7	8
Wilson County	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Miscellaneous	.....	.....	.....	.....	.....	1	.....	3	.....	4	.....	7	.....	16
Northern Texas	22	11	26	4	19	17	28	31	46	32	50	58	32	42
	14	6	21	9	18	5	21	4	15	9	10	5	5	5
Total Texas	36	17	47	13	37	22	49	35	61	41	60	63	37	47

District.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Batson	2	1	5	.....	3	.....	3	2	4	1	36	7
Bexar County	.....	.....	1	.....	1	.....	2	1	1	.....	5	1
Duval County	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	.....
Goose Creek	.....	.....	.....	.....	.....	.....	.....	1	2	1	6	5
Humble	14	5	10	5	9	7	22	7	13	7	106	69
Liberty County	.....	.....	.....	.....	.....	.....	.....	1	1	1	1	7
Markham	.....	.....	2	.....	1	.....	1	.....	1	.....	8	.....
Orange County	.....	.....	.....	.....	.....	1	.....	.....	.....	1	.....	5
Saratoga	2	1	3	2	4	1	4	1	3	1	34	11
Sourlake	7	.....	7	6	.....	.....	3	4	6	5	93	52
Spindletop	.....	.....	3	.....	.....	.....	2	.....	2	1	11	3
Washington County	.....	.....	.....	.....	2	.....	.....	1	.....	.....	2	1
Williamson County	13	15	12	5	7	7	8	5	7	3	112	103
Wilson County	.....	1	1	.....	.....	.....	.....	.....	.....	.....	1	1
Miscellaneous	.....	9	.....	10	.....	3	.....	12	.....	7	.....	72
Northern Texas	39	32	44	28	27	19	45	35	40	28	418	337
	16	7	11	10	12	8	25	9	27	14	195	91
Total Texas	55	39	55	38	39	27	70	44	67	42	613	428

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Wells completed in coastal Texas, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	26	13	26	38	22	15	8	6	3	11	41	21	34	42	33
February	35	41	25	18	26	10	8	18	4	4	46	49	43	24	30
March	29	35	32	22	19	17	8	16	7	17	46	43	49	29	36
April	30	45	33	20	28	14	13	30	18	31	44	58	66	39	59
May	31	24	20	37	46	10	13	15	8	32	41	37	38	47	78
June	58	25	31	27	50	17	10	31	10	58	76	35	65	37	108
July	40	23	36	37	32	11	8	27	18	42	51	31	63	56	75
August	24	30	31	32	39	.....	9	30	20	32	41	39	61	54	72
September	19	27	25	21	44	.....	10	20	8	28	33	37	45	30	73
October	16	38	23	23	27	9	8	21	16	19	25	46	44	39	46
November	20	34	19	26	45	9	5	16	13	35	29	39	35	40	81
December	24	18	24	22	40	5	9	25	5	28	29	27	49	27	70
	352	353	325	323	418	117	109	255	130	337	502	462	592	464	761

[a] Including gas wells.

Initial daily production of new wells completed in coastal Texas in 1915, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Batson	50	208	70	45	95	40	45	95	128	65	40	50	931
Bexar County	.....	.....	.....	.....	.....	.....	.....	.....	25	15	95	50	185
Duval County	.....	.....	.....	25	.....	30	.....	25	.....	.....	.....	.....	80
Goose Creek	300	.....	.....	.....	.....	225	165	.....	.....	.....	.....	20	710
Humble	13,000	11,330	2,200	500	9,740	10,560	12,455	12,480	35,285	59,410	85,470	14,400	266,830
Liberty County	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	20	20
Markham	.....	.....	200	.....	.....	40	50	.....	25	500	60	1,500	2,375
Saratoga	40	100	100	70	125	240	160	130	155	1,000	170	220	2,510
Souriake	1,765	2,795	815	2,660	1,250	1,505	600	1,150	485	.....	2,210	3,460	18,695
Spindletop	25	25	.....	.....	10	.....	.....	.....	25	.....	55	20	160
Washington County	.....	.....	.....	.....	.....	.....	.....	.....	.....	40	.....	.....	40
Williamson County	.....	150	5,500	8,925	10,700	9,310	3,655	2,700	1,020	400	610	200	43,170
Wilson County	.....	.....	.....	.....	.....	.....	.....	.....	5	.....	.....	.....	5
	15,180	14,608	8,885	12,225	21,920	21,950	17,130	16,580	37,153	61,430	88,710	19,940	335,711
Northern Texas	507	1,150	750	633	665	630	800	955	700	385	1,138	1,180	9,493
Total Texas	15,687	15,758	9,635	12,858	22,585	22,580	17,930	17,535	37,853	61,815	89,848	21,120	345,204

Total and average initial daily production of new wells in coastal Texas, 1911–1915, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Batson	606	829	5,980	2,191	931	26.3	36.0	117.3	43.0	25.9
Bexar County	.....	.....	.....	.....	185	.....	.....	.....	.....	37.0
Dayton	.....	.....	.....	400	.....	.....	.....	.....	200.0	.....
Duval County	.....	.....	.....	.....	80	.....	.....	.....	.....	26.7
Goose Creek	250	3,005	3,130	2,375	710	250.0	176.8	115.9	69.9	118.3
Humble	4,597	5,615	8,119	22,842	266,830	37.6	62.3	91.2	496.6	2,517.3
Liberty County	.....	.....	.....	.....	20	.....	.....	.....	.....	20.0
Markham	13,275	10,040	380	25	2,375	491.7	323.8	47.5	25.0	296.8
Orange County	.....	.....	.....	350	.....	.....	.....	.....	116.7	.....
Saratoga	2,309	9,350	7,883	900	2,510	51.3	102.7	160.9	52.9	73.8
Souriake	4,463	1,530	11,443	130,341	18,695	58.7	28.3	178.8	931.0	201.0
Spindletop	7,240	2,713	1,778	1,191	160	124.8	57.7	61.3	49.6	14.5
Washington County	.....	.....	.....	.....	40	.....	.....	.....	.....	20.0
Williamson County	.....	.....	.....	.....	43,170	.....	.....	.....	.....	385.4
Wilson County	.....	.....	.....	.....	5	.....	.....	.....	.....	5.0
Miscellaneous	.....	.....	265	80	.....	.....	.....	33.1	16.0	.....
	32,740	33,082	38,978	160,695	335,711	93.0	93.7	119.9	497.5	803.1
Northern Texas	19,180	28,213	57,435	25,003	9,493	228.3	94.3	98.9	50.3	48.7
Total Texas	51,920	61,295	96,413	185,698	345,204	119.1	94.0	106.4	226.4	563.1

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Total initial daily production of new wells in coastal Texas, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911.....	5,970	5,890	2,115	6,380	1,561	3,455	2,708	935	1,355	772	619	980	32,740	2,728
1912.....	935	5,495	3,359	3,435	875	1,805	5,266	2,038	6,055	1,080	1,259	1,481	33,082	2,757
1913.....	1,147	3,652	10,936	2,305	5,595	3,195	1,335	1,147	1,757	2,186	1,016	4,707	38,978	3,248
1914.....	5,026	3,696	20,075	25,249	12,816	16,907	15,923	12,823	12,773	12,320	14,172	8,915	160,695	13,391
1915.....	15,180	14,608	8,835	12,225	21,920	21,950	17,130	16,580	37,153	61,430	88,710	19,940	335,711	27,976

LOUISIANA.

GENERAL STATEMENT.

The output of petroleum in Louisiana in 1915 exceeded the output in 1914 by 3,882,104 barrels, or 27 per cent, and established a new record for production of oil in this State.

The increase was general, amounting to 28 per cent in the northwestern Louisiana or stratum division and to 24 per cent in the coastal or salt-dome division.

Market reverses in the early months of the year, reflecting the general depression in value of crude oil throughout the country, though followed by steady advances in prices during the closing months, resulted in an average price for the entire Louisiana output of 59 cents per barrel, which was lower by 31 cents than the average price in 1914, but higher than the average price received in any year from 1908 to 1911, inclusive. The average price of oil in the stratum division declined from 95 cents per barrel in 1914 to 62 cents in 1915 and that of oil in the salt-dome division from 67 cents in 1914 to 46 cents in 1915.

Credit for the increased output of oil in 1915 is due chiefly to the contribution of the Crichton field—a discovery of the year in the stratum division—which amounted to more than 6,000,000 barrels, only half of which was required to offset the decline in the Caddo and De Soto districts due to conditions of repressed development.

DEVELOPMENT.

The total of wells drilled in Louisiana in 1915 is misleading as to the activity of development in the various areas of production. From the facts that 565 wells were completed and that 422, or 75 per cent, produced oil, it might be inferred that activity was as great as in 1914 and that it was more successful. An analysis of the statistics shows, however, that outside the Red River district in which the Crichton field was developed, activity was notably less than in 1914. Market conditions account largely for the lethargy in the districts where the limits of production have been defined, whereas unrestrained competition among owners of leases on innumerable small tracts in an undefined oil field is responsible for the excess of activity in the Red River district.

Owing chiefly to the results obtained in the Crichton field, the average output of new oil wells in the stratum division increased from 338 barrels per well in 1914 to 568 barrels for the first day of productive life in 1915. In the salt-dome division the initial yield of oil wells completed in 1915 was 619 barrels per well.

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STRATUM DIVISION.

Caddo district.—In the various areas of production that comprise the Caddo district activity attained about one-half its normal proportions. The prices obtainable during much of the year for oil of the Caddo light grade were insufficient to warrant the cost of wells to the lower sands, and activity was centered in the heavy-oil districts, where drilling was less expensive. The Monterey subdivision of this district supported a fair activity which resulted in a westward advance of production in secs. 8 and 17, T. 21 N., R. 16 W., almost to the State boundary and caused increased activity in the adjacent part of Marion County, Tex. A 4,000-barrel well completed in September by the Gulf Refining Co. on the Duhon-Toler lease, in sec. 3 of this township, resulted in a temporary drilling boom, which subsided, however, when subsequent wells were brought in as very ordinary producers or as dry holes.

In the vicinity of Shreveport the most important event of the year was the completion in November of a gas well estimated to have a capacity of 22,000,000 cubic feet open flow, on the Youree lease in sec. 17, T. 17 N., R. 13 W., just south of the city limits. The importance of this discovery lay not so much in its value as a contributor to the gas supply of the city as in its location in new territory.

De Soto district.—In the Naborton pool, discovered in 1913, operations were notably dull in 1915, and as a consequence production in that district declined more than 50 per cent compared with 1914. Late in the year an increase in drilling operations resulted from improved market conditions and from the completion in October by the Producers Oil Co. of a 3,500-barrel well on the Sanders lease, half a mile west of previous production.

Red River district.—In the Abington field, discovered in 1914, efforts to extend the area of production south of the Marston property were unsuccessful, but efforts to extend it to the east were remarkably successful, resulting as they did in the discovery of a prolific oil field on the east side of Red River, just south of the village of Crichton. The first well of consequence in the Crichton field was No. 1 Weiss, in sec. 18, T. 13 N., R. 10 W., completed January 27, by the Commerce Oil & Gas Co. (now controlled by the Louisiana Oil Refining Co.) and rated as a 5,000-barrel producer.

The completion of this well inaugurated a drilling campaign which in the succeeding months of 1915 resulted in the completion of 251 additional oil wells and the partial development of a field that extended to the east into secs. 16 and 21, to the south into sec. 30, T. 13 N., R. 10 W., and to the southwest into sec. 26, T. 13 N., R. 11 W.

The relatively low gasoline content of oil in this field rendered it less desirable for refining than other grades of oil produced in the stratum division, and on July 13 the purchasing agencies gave it a separate classification and a price quotation which ranged throughout the year from 5 to 25 cents a barrel below that for De Soto grade.

Sabine district.—Operations in the Sabine or Pelican district, which embraces an indefinite area in northern Sabine and southern De Soto parishes, were slight on account of the depth involved—3,000 feet or more—and the small capacity of the few wells completed. The district is credited with a marketed output of 10.631 barrels in 1915.

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Miscellaneous tests.—Unsuccessful tests of interest far in advance of areas of present production were reported abandoned in the northwestern Louisiana division in 1915, as follows:

Caddo Parish:
June—Atlas Oil Co., on Gale plantation, in sec. 30, T. 16 N., R. 12 W.; depth, 3,000 feet.
Bossier Parish:
January—D. C. Richardson, in sec. 15, T. 15 N., R. 11 W., near Pool; depth, 2,600 feet.
August—Atlas Oil Co., in sec. 11, T. 18 N., R. 13 W., No. 1 Scott; depth, 2,600 feet.
September—Giddings Oil & Gas Co., in sec. 34, T. 16 N., R. 11 W., No. 1 Smith; depth, 2,600 feet.
December—J. P. Flourney, in sec. 8, T. 22 N., R. 14 E., near Missionary; depth, below 2,500 feet.
La Salle Parish:
August—Jena Oil & Gas Co., in T. 8 N., R. 3 E., near Trout; depth, 3,450 feet.
Ouachita Parish:
July—Monroe Oil & Gas Co., in T. 18 N., R. 4 E., at Monroe; depth, 2,200 feet.
Tensas Parish:
December—Point Pleasant Oil Co., on the Bland plantation, 2 miles north of Newellton, in T. 13 N., R. 12 E.; depth, 3,000 feet.
De Soto Parish:
January—H. L. Heilperin and others, in sec. 9, T. 14 N., R. 15 W., No. 1 Fisher; depth, 2,680 feet.
July—H. L. Heilperin and others, in sec. 16, T. 14 N., R. 15 W., No. 2 Fisher; depth, 1,550 feet.
Red River Parish:
July—Emmett Oil Co., in sec. 1, T. 12 N., R. 10 W., 2 miles north of Coushatta; depth, 2,600 feet.
August—Lake End Oil & Gas Co., in sec. 32, T. 11 N., R. 9 W., No. 1 Preston; depth, 1,550 feet. National Oil & Gas Co., in sec. 9, T. 11 N., R. 9 W., No. 1 Holly, 3 miles south of Coushatta; depth, 3,250 feet.
Natchitoches Parish:
December—Campti Oil & Gas Co., in sec. 27, T. 11 N., R. 8 W., No. 1 Bushwell; depth, 2,350 feet.
Sabine Parish:
December—Negreet Oil & Gas Co., in sec. 5, T. 5 N., R. 12 W., near Negreet; depth, 3,800 feet.

SALT-DOME DIVISION.

Vinton.—Activity in the Vinton pool in 1915 was restricted to the development of "inside" locations and production declined 16 per cent from the output in 1914.

Edgerly.—Drilling in the Edgerly pool was active throughout the year and a number of excellent wells were completed. No appreciable additions were made to the area of production as interest was centered more in the development of the deep sands found at 3,100 to 3,300 feet. The success of operations in 1915 is indicated by the increase of 139 per cent in output, compared with 1914, and by the fact that only two barren wells were completed in the pool during the year.

Jennings.—The 5 per cent increase in output credited to Jennings in 1915 resulted largely from the success that attended the deepening of old wells in this pool.

Anse la Butte.—The output of the old Anse la Butte pool in St. Martin Parish was increased 13 per cent in 1915 by the completion in February of one oil well that was rated as a 50-barrel producer. A deep test in this pool completed in January at a depth of 3,145 feet was unsuccessful.

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Welsh.—Production in the old shallow pool at Welsh, Calcasieu Parish, declined 12 per cent in 1915. Only two oil wells were completed during the year.

Miscellaneous tests.—A number of wildcat tests were begun in southern Louisiana late in 1915 as a consequence of the advancing market for heavy oils. During the year a number of advance tests were completed, of which the following, though unsuccessful, are of interest:

Acadia Parish:
March—Robinson Oil Co., north of Jennings; depth, 2,250 feet.
Calcasieu Parish:
March—John Champion and others, 3 miles northeast of Sulphur; depth, 3,000 feet.
June—Mutual Oil Co., at Lake Charles; depth, 2,200 feet. Investors Oil Co., 1 mile southeast of Sulphur; depth, 3,500 feet.
Catahoula Parish:
June—Sicily Island Oil Co., No. 2, at Sicily Island; depth, 1,500 feet.
July—Sicily Island Oil Co., No. 3, at Sicily Island; depth, 1,620 feet.
Jefferson Davis Parish:
December—Welsh Oil Co., at Welsh; depth, 1,080 feet. Louisiana Oil & Gas Co., at Lake Arthur; depth, 2,640 feet.
Vermilion Parish:
February—Vermilion Petroleum Co., 2 miles north of Abbeville; depth, 2,900 feet.

MARKETED PRODUCTION.

Petroleum marketed in Louisiana, 1906–1915, in barrels.

Year.	Northern Louisiana.				
	Caddo.	De Soto.	Red River.	Sabine.	Total.
1906	3,358				3,358
1907	50,000				50,000
1908	499,937				499,937
1909	1,028,818				1,028,818
1910	5,090,793				5,090,793
1911	6,995,828				6,995,828
1912	7,177,949				7,177,949
1913	9,781,560				9,781,560
1914	7,572,254	[a] 3,834,593	401,622		11,808,469
1915	6,471,879	1,797,175	6,802,349	10,631	15,082,034

Year.	Coastal Louisiana.						Total.
	Jennings.	Welsh.	Anse la Butte.	Vinton.	Edgerly.	Total.	
1906	9,025,174	23,996	25,000			9,074,170	9,077,528
1907	4,842,520	47,316	60,385			4,950,221	5,000,221
1908	5,111,577	31,555	145,805			5,288,937	5,788,874
1909	1,966,614	26,169	37,930			2,030,713	3,059,531
1910	1,625,159	54,724	44,018	26,701		1,750,602	6,841,395
1911	1,180,177	27,901	62,411	2,454,103		3,724,592	10,720,420
1912	1,105,711	22,140	25,000	932,639		2,085,490	9,263,439
1913	790,648	31,144	6,612	1,888,864		2,717,268	12,498,828
1914	412,036	18,629	18,623	1,465,302	586,376	2,500,966	14,309,435
1915	434,815	16,451	20,982	1,234,227	1,403,030	3,109,505	18,191,539

[a] Includes Sabine.

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Petroleum marketed in Louisiana in 1914 and 1915, in barrels.

1914.

Month.	Northern Louisiana.			
	Caddo.	De Soto.[a]	Red River.	Total.
January	704,739	293,192	.....	997,931
February	603,935	262,297	.....	866,232
March	671,476	523,629	.....	1,195,105
April	659,048	279,258	.....	938,306
May	677,675	223,728	33,331	934,734
June	654,020	444,238	62,301	1,160,559
July	637,295	521,995	60,496	1,219,786
August	636,937	316,622	80,455	1,034,014
September	604,470	287,645	58,437	950,552
October	601,474	244,934	49,947	896,355
November	556,634	201,788	56,655	815,077
December	564,551	235,267	.....	799,818
	7,572,254	3,834,593	401,622	11,808,469

Month.	Coastal Louisiana.						Total.
	Jennings.	Welsh.	Anse la Butte.	Vinton.	Edgerly.	Total.	
January	45,502	1,966	2,067	131,647	4,892	186,094	1,184,025
February	34,544	1,166	2,246	113,312	16,771	168,039	1,034,271
March	37,435	1,166	1,637	175,626	20,482	236,346	1,431,451
April	32,321	1,166	1,333	131,562	50,445	216,827	1,155,133
May	28,842	1,167	1,229	118,924	64,183	214,345	1,149,079
June	29,504	1,167	1,339	91,117	64,291	187,418	1,347,977
July	29,702	1,167	1,226	104,548	42,626	179,269	1,399,055
August	32,930	1,167	1,303	139,592	44,096	219,088	1,253,102
September	33,308	3,451	1,068	117,303	57,638	212,768	1,163,320
October	35,288	1,167	918	112,503	81,210	231,086	1,127,441
November	36,099	1,167	2,853	113,126	77,630	230,875	1,045,952
December	36,561	2,712	1,384	116,042	62,112	218,811	1,018,629
	412,036	18,629	18,623	1,465,302	586,376	2,500,966	14,309,435

[a] Includes Sabine.

1915.

Month.	Northern Louisiana.				
	Caddo.	De Soto.	Red River.	Sabine.	Total.
January	560,925	158,757	95,638	1,049	816,369
February	527,645	170,225	203,651	1,011	902,532
March	563,941	190,083	325,142	221	1,069,387
April	534,933	243,611	389,142	505	1,168,191
May	540,486	344,491	385,106	1,067	1,271,150
June	533,905	98,385	607,769	801	1,240,860
July	524,589	96,151	883,650	1,469	1,505,859
August	649,238	87,182	917,132	319	1,653,871
September	592,904	85,456	911,920	2,043	1,592,323
October	501,846	117,997	725,382	1,144	1,346,369
November	475,829	101,675	690,975	360	1,268,839
December	465,638	113,162	666,842	642	1,246,284
	6,471,879	1,797,175	6,802,349	10,631	15,082,034

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Petroleum marketed in Louisiana in 1914 and 1915, in barrels—Continued.

1915—Continued.

Month.	Coastal Louisiana.						Total.
	Jennings.	Welsh.	Anse la Butte.	Vinton.	Edgerly.	Total.	
January	37,662	3,328	1,179	106,063	89,063	237,295	1,053,664
February	33,376	858	1,762	133,492	101,017	270,505	1,173,037
March	35,814	1,640	2,984	138,067	95,226	273,751	1,343,138
April	34,293	858	1,327	126,916	124,623	288,017	1,456,208
May	33,328	1,570	2,105	88,906	97,607	223,516	1,494,666
June	35,366	858	1,492	86,395	106,414	230,525	1,471,385
July	32,061	858	1,938	91,937	117,714	244,508	1,750,367
August	37,002	858	1,026	86,989	147,553	273,428	1,927,299
September	36,231	1,609	1,418	90,071	116,994	246,323	1,838,646
October	39,880	2,294	1,916	85,194	161,688	290,972	1,637,341
November	39,839	858	2,364	77,109	128,509	248,679	1,517,518
December	39,963	862	1,471	123,068	116,622	281,986	1,528,270
	434,815	16,451	20,982	1,234,227	1,403,030	3,109,505	18,191,539

Petroleum marketed in Louisiana in 1914 and 1915, with increase or decrease.

District.	1914			1915			Increase or decrease.	
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Barrels.	Per cent.
Northern Louisiana:								
Caddo	7,572,254	$7,177,535	$0.948	6,471,879	$4,597,558	$0.710	−1,100,375	− 14.53
De Soto	[a]3,834,593	[a]3,649,922	.952	1,797,175	1,108,875	.617	−2,037,418	− 53.13
Red River	401,622	379,229	.944	6,802,349	3,652,124	.537	+6,400,727	+1,593.72
Sabine	.....	.....	.....	10,631	6,786	.638	+ 10,631	+ 100.00
	11,808,469	11,206,686	.949	15,082,034	9,365,343	.621	+3,273,565	+ 27.72
Coastal Louisiana:								
Jennings	412,036	374,611	.909	434,815	211,114	.486	+ 22,779	+ 5.53
Welsh	18,629	17,614	.946	16,451	13,815	.840	− 2,178	− 11.69
Anse la Butte	18,623	17,036	.915	20,982	16,388	.781	+ 2,359	+ 12.67
Vinton	1,465,302	983,588	.671	1,234,227	564,509	.459	− 231,075	− 15.77
Edgerly	586,376	287,362	.490	1,403,030	633,484	.452	+ 816,654	+ 139.27
	2,500,966	1,680,211	.672	3,109,505	1,439,310	.463	+ 608,539	+ 24.33
Total Louisiana	14,309,435	12,886,897	.901	18,191,539	10,804,653	.594	+3,882,104	+ 27.13

[a] Includes Sabine.

Petroleum marketed, value, and average price per barrel in the Caddo field, 1906–1915.

Year.	Caddo, La.			Marion County, Tex.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1906	3,358	$2,183	$0.650	.....	.....	.....	3,358	$2,183	$0.650
1907	50,000	38,863	.777	.....	.....	.....	50,000	38,863	.777
1908	499,937	214,048	.428	.....	.....	.....	499,937	214,048	.428
1909	1,028,818	549,081	.533	.....	.....	.....	1,028,818	549,081	.533
1910	5,090,793	2,292,349	.451	251,717	$102,842	$0.409	5,342,510	2,395,191	.448
1911	6,995,828	3,653,725	.522	677,689	365,067	.539	7,673,517	4,018,792	.524
1912	7,177,949	5,419,541	.755	362,870	290,974	.802	7,540,819	5,710,515	.757
1913	9,781,560	9,812,342	1.003	262,392	261,965	.998	10,043,952	10,074,307	1.003
1914	7,572,254	7,177,535	.948	180,584	175,922	.974	7,752,838	7,353,457	.948
1915	6,471,879	4,597,558	.710	123,464	88,079	.713	6,595,343	4,685,637	.710
	44,672,376	33,757,225	.756	1,858,716	1,284,849	.691	46,531,092	35,042,074	.753

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RAILROAD SHIPMENTS.

Petroleum shipped by rail from stations on the Louisiana Western Railroad, Kansas City Southern Railway and lines of the Louisiana Railway & Navigation Co. in Louisiana, in 1914 and 1915, in barrels.

1914.

Month.	Anse la Butte.	Caddo oil.			De Soto oil.	Jennings oil.			Vinton.	Total.
		Lewis.	Oil City.	Vivian.	Mansfield and South Mansfield.	Egan.	Jennings.	Mermentau.		
January	1,629	8,636	48,849	2,043	137,886	155	27,672	2,299	.....	229,169
February	1,788	4,405	39,515	1,785	90,627	310	6,429	1,749	154	146,763
March	1,179	7,384	41,721	4,535	131,277	.....	13,279	2,298	.....	201,673
April	875	6,623	30,295	1,336	31,884	.....	1,528	2,682	945	76,168
May	771	12,408	36,452	3,282	45,091	465	3,033	4,563	3,029	109,094
June	881	6,549	24,405	1,577	78,554	773	1,495	12,361	4,860	131,455
July	768	4,888	28,709	4,137	22,560	1,934	2,642	10,312	16,479	92,429
August	845	54,228	24,228	2,732	.....	1,768	2,561	17,244	1,963	105,569
September	609	46,281	23,653	571	.....	10,105	956	574	1,363	84,112
October	459	2,967	31,925	190	.....	11,415	3,643	1,725	4,216	56,540
November	2,394	1,860	34,335	190	.....	7,006	2,820	5,188	1,915	55,708
December	925	4,849	45,242	.....	.....	1,230	13,536	3,956	554	70,292
	13,123	161,078	409,329	22,378	537,879	35,161	79,594	64,951	35,478	1,358,971

1915.

Month.	Anse la Butte.	Caddo oil.		Jennings oil.			Red River.	Vinton.	Total.
		Lewis.	Oil City.	Egan.	Jennings.	Mermentau.			
January	613	3,795	35,178	619	4,670	191	.....	346	45,412
February	1,196	966	29,658	154	2,503	766	.....	460	35,703
March	2,418	5,195	29,583	1,063	10,401	1,341	.....	154	50,155
April	761	484	26,113	773	12,067	3,285	.....	1,052	44,535
May	1,538	6,012	18,563	2,150	6,310	7,869	.....	912	43,354
June	925	5,719	21,268	1,280	12,642	10,802	193	.....	52,829
July	1,371	1,623	20,166	2,385	22,435	6,929	.....	.....	54,909
August	459	9,534	20,448	3,226	8,489	18,795	.....	.....	60,951
September	851	5,023	34,073	3,800	1,689	6,298	24,126	154	76,014
October	1,349	1,434	18,268	4,706	26,292	5,403	31,353	.....	88,805
November	1,797	5,515	20,619	1,061	26,511	3,381	33,861	.....	92,745
December	904	6,719	21,201	457	3,822	7,599	34,299	.....	75,001
	14,182	52,019	295,138	21,674	137,831	72,659	123,832	3,078	720,413

SUMMARY OF WELLS DRILLED.

The statistics of field operations presented in the tables following are compiled from trade journal sources and differ somewhat from those on page 591, obtained from reports received directly from the oil producers.

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Wells completed in Louisiana, 1911–1915.

District.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Northern Louisiana:															
Caddo	246	239	356	208	67	63	62	92	[b]57	[b]37	341	353	[c]518	[b]294	[b]112
De Soto	.....	.....	.....	77	23	.....	.....	.....	24	17	.....	.....	(*d*)	123	49
Red River	.....	.....	.....	14	257	.....	.....	.....	7	30	.....	.....	.....	21	296
Sabine	.....	.....	.....	3	2	.....	.....	.....	3	5	.....	.....	(*d*)	7	7
	246	239	356	302	349	63	62	92	91	80	341	353	518	445	464
Coastal Louisiana:															
Anse la Butte	.....	3	5	3	1	1	4	1	.....	3	1	7	6	3	4
Calcasieu	.....	.....	4	.....	.....	.....	.....	1	2	2	.....	.....	5	2	2
Cameron	.....	.....	.....	.....	.....	.....	.....	2	1	.....	.....	.....	2	1	.....
Edgerly	.....	.....	.....	30	35	.....	.....	.....	16	2	.....	.....	.....	46	38
Evangeline	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	.....
Jennings	4	24	19	12	16	1	9	9	9	6	5	33	28	21	22
Pine Prairie	.....	1	2	.....	.....	.....	5	4	.....	.....	.....	6	6	.....	.....
Rapides	.....	.....	.....	.....	.....	.....	.....	1	3	.....	.....	.....	1	3	.....
Terrebonne	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....
Vinton	54	31	45	22	19	27	7	34	12	11	96	38	79	35	31
Welsh	5	.....	6	5	2	3	.....	4	5	2	10	.....	10	10	4
	63	59	81	72	73	32	25	57	48	26	112	84	139	121	101
Total Louisiana	309	298	437	374	422	95	87	149	139	115	453	437	657	566	565

[a] Including gas wells.
[b] Including Bossier Parish.
[c] Including Bossier, De Soto, and Sabine parishes.
[d] Included in Caddo.

Oil wells and dry holes drilled in Louisiana in 1915.

District.	January.		February.		March.		April.		May.		June.		July.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Northern Louisiana:														
Caddo	8	1	10	2	4	2	7	4	3	.....	7	6	3	3
De Soto	2	2	5	3	2	1	4	2	.....	.....	3	.....	.....	.....
Red River	6	2	7	3	14	2	20	.....	32	1	30	4	32	3
Sabine	.....	.....	.....	1	.....	.....	1	1	.....	.....	1	3	.....	.....
	16	5	22	9	20	5	32	7	35	1	41	13	35	6
Coastal Louisiana:														
Anse la Butte	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1	.....
Calcasieu	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....
Edgerly	1	.....	1	.....	2	.....	4	.....	4	.....	5	1	6	.....
Jennings	.....	.....	1	1	.....	1	1	1	2	.....	2	1	1	1
Vinton	1	.....	1	1	1	.....	2	3	1	1	1	.....	4	1
Welsh	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
	2	.....	3	3	3	1	7	5	7	1	8	3	13	2
Total Louisiana	18	5	25	12	23	6	39	12	42	2	49	16	48	8

District.	August.		September.		October.		November.		December.		Total.	
	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.	Oil.	Dry.
Northern Louisiana:												
Caddo	7	3	3	1	.....	5	9	8	6	2	67	[a]37
De Soto	.....	1	.....	1	4	1	.....	1	3	5	23	17
Red River	28	8	31	2	22	2	16	2	19	1	257	30
Sabine	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	5
	35	12	34	4	26	8	25	11	28	8	349	89
Coastal Louisiana:												
Anse la Butte	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	1	3
Calcasieu	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
Edgerly	3	.....	2	1	3	.....	2	.....	2	.....	35	2
Jennings	3	.....	2	1	1	.....	3	.....	.....	.....	16	6
Vinton	2	.....	2	1	1	1	.....	2	3	1	19	11
Welsh	.....	.....	.....	.....	1	1	.....	.....	.....	1	2	2
	8	1	6	4	6	2	5	2	5	2	73	26
Total Louisiana	43	13	40	8	32	10	30	13	33	10	422	115

[a] Includes Bossier Parish.

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Wells completed in Louisiana, 1911–1915.

Month.	Oil.					Dry.					Total completed.[a]				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
January	20	12	36	28	18	12	2	12	5	5	32	17	53	38	24
February	33	19	25	33	25	15	8	10	10	12	51	31	44	48	41
March	49	19	28	44	23	12	1	9	12	6	64	22	44	60	30
April	26	14	45	35	39	6	6	16	12	12	33	21	65	50	54
May	39	30	39	49	42	9	4	5	18	2	52	34	49	74	45
June	29	28	23	50	49	6	11	17	17	16	38	46	44	69	67
July	27	25	51	33	48	9	7	15	10	8	39	37	73	46	57
August	18	28	37	29	43	8	6	10	12	13	42	43	54	47	59
September	21	34	43	20	40	3	15	12	8	8	32	57	58	36	48
October	14	27	34	12	32	4	15	11	12	10	20	44	51	29	42
November	16	37	34	19	30	5	8	14	11	13	25	51	51	33	46
December	17	25	42	22	33	6	4	18	12	10	25	34	71	36	52
	309	298	437	374	422	95	87	149	139	115	453	437	657	566	565

[a] Including gas wells.

Initial daily production of new wells completed in Louisiana in 1915, in barrels.

District.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Northern Louisiana:													
Caddo	1,480	1,090	570	690	240	440	140	2,270	4,950	.....	1,925	525	14,320
De Soto	85	970	360	1,275	.....	355	.....	.....	.....	3,625	.....	1,520	8,190
Red River	2,825	8,985	19,505	16,665	19,050	12,515	24,376	20,965	25,400	6,295	11,525	7,445	175,551
Sabine	.....	.....	.....	15	.....	40	.....	.....	.....	.....	.....	.....	55
	4,390	11,045	20,435	18,645	19,290	13,350	24,516	23,235	30,350	9,920	13,450	9,490	198,116
Coastal Louisiana:													
Anse la Butte	.....	.....	.....	.....	.....	.....	50	.....	.....	.....	.....	.....	50
Edgerly	200	700	2,500	4,400	1,875	7,400	3,615	2,300	3,000	5,600	770	600	32,960
Jennings	.....	40	.....	300	115	175	115	245	220	2,000	180	.....	3,390
Vinton	300	200	600	20	75	50	1,010	450	700	150	.....	5,160	8,715
Welsh	.....	.....	.....	.....	.....	.....	35	.....	.....	35	.....	.....	70
	500	940	3,100	4,720	2,065	7,625	4,825	2,995	3,920	7,785	950	5,760	45,185
Total Louisiana	4,890	11,985	23,535	23,365	21,355	20,975	29,341	26,230	34,270	17,705	14,400	15,250	243,301

Total and average initial daily production of new wells in Louisiana, 1911–1915, by districts, in barrels.

District.	Total initial production.					Average per well.				
	1911	1912	1913	1914	1915	1911	1912	1913	1914	1915
Northern Louisiana:										
Caddo	169,123	84,098	[a]151,955	19,241	14,320	687.5	351.9	426.8	92.5	213.7
De Soto	.....	.....	.....	70,612	8,190	.....	.....	.....	917.0	356.1
Red River	.....	.....	.....	12,185	175,551	.....	.....	.....	879.4	683.1
Sabine	.....	.....	.....	155	55	.....	.....	.....	51.7	27.5
	169,123	84,098	[a]151,955	102,193	198,116	687.5	351.9	426.8	338.4	567.7
Coastal Louisiana:										
Anse la Butte	.....	590	2,362	340	50	.....	196.7	472.4	113.3	50.0
Calcasieu	.....	.....	1,780	.....	.....	.....	.....	445.0	.....	.....
Edgerly	.....	.....	.....	38,785	32,960	.....	.....	.....	1,292.8	941.7
Jennings	480	5,905	4,813	592	3,390	120.0	246.0	253.3	49.3	211.9
Pine Prairie	.....	1,050	80	.....	.....	.....	1,050.0	40.0	.....	.....
Vinton	73,550	17,975	46,605	43,070	8,715	1,362.0	579.8	1,035.7	1,957.7	458.7
Welsh	115	.....	100	127	70	23.0	.....	16.7	25.4	35.0
	74,145	25,520	55,740	82,914	45,185	1,176.9	432.5	688.1	1,151.6	619.0
Total Louisiana	243,268	109,618	207,695	185,107	243,301	787.3	367.8	475.3	494.9	576.5

[a] Includes De Soto and Sabine parishes.

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Total initial daily production of new wells in Louisiana, 1911–1915, by months, in barrels.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Monthly average.
1911.....	35,275	29,325	17,110	38,595	62,150	6,980	5,405	4,505	23,465	4,886	5,292	10,280	243,268	20,272
1912.....	10,855	5,257	10,070	18,300	11,447	3,583	4,931	3,391	17,605	5,600	13,631	4,948	109,618	9,135
1913.....	21,064	12,410	27,220	28,860	26,986	13,966	15,675	22,626	6,580	11,163	3,447	17,698	207,695	17,308
1914.....	8,570	10,155	36,305	22,493	17,057	26,212	17,742	10,785	17,367	4,805	6,390	7,226	185,107	15,426
1915.....	4,890	11,985	23,535	23,365	21,355	20,975	29,341	26,230	34,270	17,705	14,400	15,250	243,301	20,275

CALIFORNIA OIL FIELD.

GENERAL STATEMENT.

In marked contrast to the reviews of the petroleum situation in California in the last nine years the review for 1915 records a decline in output and a year devoid of spectacular features. As a consequence of this decline and of a remarkable increase in the output of petroleum in Oklahoma, California was forced to yield first rank among the oil-producing States, which it had held since 1908. Although the decrease of 13,000,000 barrels is greater than the combined output of oil in Pennsylvania, New York, and southeastern Ohio in 1915, it represents a decline of only 13 per cent below the quantity marketed in California in 1914. This decrease, which was well distributed among the oil-producing districts of the State, reflects the condition of slight drilling activity in 1915 and should not be interpreted as indicating that the productive areas have been fully developed or that the productive sands are becoming exhausted. The paucity of drilling is accounted for by a depressed condition of the market for crude oil inherited directly from 1914 but extending back two or three years further over the period of excessive production and stock accumulation resulting from the completion of a great number of phenomenally productive wells in the Midway-Sunset district.

The average price received for the petroleum marketed in California in 1915 was 42 cents a barrel, a decrease of 6 cents from the average price in 1914. Market quotations on California grades of petroleum were fairly steady throughout the year, a 5-cent cut affecting heavy oils in the San Joaquin division on June 7 and a corresponding advance affecting the same grades on October 26. This was followed by a general advance of 2½ to 5 cents a barrel on all grades, except Ventura County and Santa Maria, effective November 20, and by a further advance amounting to from 3 to 5 cents a barrel on all grades in all districts, effective December 28. The last advance was accompanied by a reclassification of the types of oil produced in the three principal divisions in the State—San Joaquin Valley, Whittier-Fullerton, and Ventura-Newhall—on the basis of specific gravity, in which increases of each full degree in gravity Baumé above 18° in the first two divisions and above 25° in the last division are accorded an increase of 1 cent a barrel above the basic quotation. A single grade is made of crude oil below 17.9° Baumé in the first and second divisions and below 25.9° Baumé in the third.

The enormous quantity of fuel grades of crude petroleum accumulated in California in the last two years resulted in low prices for this commodity in 1915, though a strengthening tendency was apparent

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in market quotations for this grade at the end of the year. Consumers who secured long-time contracts at the prices current in midsummer were in a position to secure better terms than those who sought new contracts or renewals at the close of the year.

By the completion of its pipe line from Caliola, just east of the Coalinga district, to Martinez, on San Francisco Bay, a distance of 173 miles, and by the erection of a modern refinery at the latter place and of a single-unit Trumble plant at Coalinga the Royal Dutch Co., which entered California late in 1913, greatly strengthened its position in 1915 through its subsidiary companies, the California Oilfields (Ltd.), the Valley Pipe Line Co., and the Shell Co. of California. The first oil pumped through the new line was received at the Martinez refinery on August 11.

The capacity of the Bakersfield refinery of the Standard Oil Co. of California was increased in 1915 from 10,000 to 30,000 barrels of crude oil a day. Equipment for the more efficient manufacture of lubricants was added to the Oleum refinery of the Union Oil Co.

DEVELOPMENT.

SAN JOAQUIN VALLEY DIVISION.

Coalinga.—The quantity of petroleum marketed from the Coalinga district in 1915 was less by 18 per cent than the corresponding output in 1914. The completion of only 20 oil wells in 1915, as compared with 35 in 1914 and 91 in 1913, indicates the state of lethargy that existed throughout the district. In the East Side field the deep territory along the southeast extension of the Coalinga anticline supported a moderate activity in secs. 2, 11, and 12, T. 20 S., R. 15 E. The deepening of an old well in the white-oil district adjacent to Oil City, northwest of the East Side field, in December, was attended with such favorable results that a revival of drilling activity in this pioneer district was planned for 1916.

Interest was sustained throughout 1915 in the advance tests of the Standard Oil Co. of California north of the East Side field on the Domengine lease, in sec. 27, T. 18 S., R. 15 E., which had reached a depth of approximately 4,000 feet in November and was idle at the close of the year awaiting the setting of cement.

McKittrick, Lost Hills, and Belridge districts.—Drilling activity in the districts included under this heading attained only moderate proportions in 1915 and the output of petroleum declined about 15 per cent compared with 1914. The only development of consequence in this area resulted from the completion in May, at a reported depth of 4,125 feet, of well No. 4 by the Belridge Oil Co., in sec. 35, T. 27 S., R. 20 E. The initial output of this well was estimated at 300 barrels of oil a day and the importance of the discovery lay in its location 20 miles northwest of McKittrick and 6 miles northwest of the Belridge development, where one or two wells drilled previously had furnished a negligible quantity of oil from shallow depths. As a consequence of this discovery additional work was started in this locality by the Belridge, Standard, and Associated Oil companies in an effort to determine the value of the prospective field.

Midway district.—More activity in drilling was apparent in the Midway district in 1915 than in any other part of the San Joaquin Valley division, though the results both as to number of wells com-

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pleted and as to new production were below those of recent years. No developments of consequence were recorded. Drilling was fairly active on the leases of the Potter Oil Co. (formerly Section 15 Oil Co.) and the General Petroleum Co. in the relatively shallow area at the north end of the district, in secs. 23 and 15, T. 31 S., R. 22 E., where a number of fair-capacity wells were completed. The best wells of the year, ranging from 500 to 1,000 barrels in initial production, were, however, completed in the Buena Vista Hills, north and east of Taft, and included both redrilled and new wells on the Associated lease in sec. 26, on the Standard leases in secs. 26 and 36, T. 31 S., R. 23 E., and on the Standard, St. Helens, and Northern Exploration Co.'s leases in sec. 16, T. 32 S., R. 24 E.

Sunset district.—The marketed output of petroleum in the Sunset district declined less than 6 per cent from that of 1914, when gusher wells of large capacity supplied a large proportion of the yield. Most of the big gushers inherited from 1914 ceased natural flow before the end of March, 1915, and the volume supplied by those that continued to produce naturally was greatly reduced. The absence of phenomenal gushers and wild wells in 1915 gave this district an appearance of desolation that the moderate activity on a few of the leases could not wholly dispel. New work was restricted to leases on Maricopa Flat and a number of wells of fair capacity were completed on the Kern Trading & Oil Co.'s lease, in sec. 31, T. 12 N., R. 23 W., some of which were merely old wells redrilled. The record well of the year in this district was No. 3 of the Union Oil Co., on the Coronation lease, in sec. 4, T. 11 N., R. 23 W., adjacent to the property of the Lakeview No. 2 Oil Co. This well was completed in September at a reported depth of 3,275 feet and was credited with an initial flow of 3,500 barrels.

Kern River district.—An increased demand for fuel oil in California and adjacent States of the Northwest and an enlargement in refinery capacity at Bakersfield resulted in an output of oil from the old Kern River district in 1915 that was greater by 13 per cent than the output in 1914.

Interest was well sustained in the efforts of the Standard Oil Co. of California to demonstrate a westward extension of the Kern River field into sec. 27, T. 28 S., R. 27 E. Well No. 1, in this section, completed in 1914 and reported in the preceding chapter of this series, continued to produce in 1915, its flow varying from 100 to 300 barrels a day during the summer months. Water pressure caused some trouble in October and recementation was necessary. In November well No. 2 was completed on this section at a reported depth of 2,467 feet and was rated at a capacity of 100 barrels of oil a day. The test in sec. 15 of this township was reported to have reached the zone of oil production at about 2,500 feet, but water troubles prevented its completion before the close of 1915. An additional test in sec. 8 was reported drilling at a depth of 1,280 feet late in December.

SOUTHERN DIVISION.

Whittier-Fullerton district.—Repressed activity in the various areas of production that comprise the Whittier-Fullerton oil district southeast of Los Angeles accounts for the 10 per cent decrease in output in 1915. Interest in drilling was centered in the developments at the east end of La Habra Valley, in the vicinity of Placentia and of the

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town site of Carlton. The successful completion in August of well No. 1 by the Quintuple Oil Co., on the Gauldin lease, in sec. 17, T. 3 S., R. 9 W., as a consistent producer rated at 300 barrels of oil a day indicated an eastward extension of nearly a mile of productive area in the Placentia field. Subsequent advance tests completed by the Standard and Placentia companies in this section resulted in wells of equal capacity and confirmed the importance of the discovery.

The completion in June by the Standard Oil Co. of California of an 800-barrel well on the Stearns-Coyote No. 2 lease, in sec. 22, T. 3 S., R. 10 W., resulted in a revival of activity in the area due north of Fullerton between the western limits of drilling in the Placentia field and the eastern limits of drilling in the Coyote Hills field.

In the Brea Canyon and Olinda fields a few good wells were completed in proved territory.

Southwest of the proved area in the Whittier field, the Standard Oil Co. completed a barren test on the Anchor lease, at a reported depth of 3,856 feet.

About 2 miles southwest of existing production in the Coyote Hills field, the American Petroleum Co. completed in May a barren well at a reported depth of 5,295 feet. This well was located near the east line of the NE. ¼ sec. 26, T. 3 S., R. 11 W., on the Macomber ranch, near Northam.

At Walnut, in San Jose Valley about 5 miles north of Olinda, a barren well, drilled in sec. 17, T. 2 S., R. 9 W., on the Currier ranch, was abandoned in January at a reported depth of 4,240 feet.

At Yorba Linda, about 5 miles east of Placentia, an uncompleted test drilled by the Yorba Oil Co. in the Santa Ana grant, was abandoned in February at a reported depth of 2,200 feet on account of loss of drilling tools. A second well was started.

At Olive, 6 miles south of Placentia, well No. 2 of the Standard Oil Co., on the Bixby ranch, on the south side of Santa Ana wash, was abandoned, dry, in January, at a reported depth of 3,150 feet.

COASTAL DIVISION.

Santa Clara County.—An increase in marketed production amounting to 81 per cent of the output in 1914, the completion of one oil well, and the abandonment of one exhausted producer constitute the record of activity in the Sargent or Watsonville district in Santa Clara County in 1915.

San Luis Obispo County.—In the Edna or Arroyo Grande district, 8 miles south of San Luis Obispo, where a heavy asphaltic oil is produced chiefly for the manufacture of asphalt at Edna, the completion of a productive well, estimated at 20 barrels initial capacity, in September aroused some speculation as to the future possibilities of the field.

Santa Barbara County.—In the Santa Maria district principal interest was centered in the operations of the Western Union Oil Co. on the Carreaga estate (Los Alamos grant), 10 miles southeast of Santa Maria. The cause of the interest lay in well No. 36, completed at a depth of 3,894 feet in the later part of May as a 500-barrel producer, which a few days after completion increased its natural flow to nearly 6,000 barrels of oil a day. This big well was brought in under control and its flow was pinched to 2,000 barrels a day until August, when

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the pressure weakened and the output dropped naturally to 1,200 barrels a day.

Though wells on adjoining locations were deepened in an effort to penetrate the prolific "pay," results obtained to the end of 1915 failed to indicate that an extensive source of new production had been tapped.

Drilling activity was revived late in 1915 in the old Casmalia field, 7 miles southwest of Santa Maria, by the Casmalia Syndicate, which acquired control of the properties of the Olympian Oil Co. and the Taft Petroleum Co. on the north flank of the Casmalia Hills.

Near Lompoc a deep test, drilled by the Union Oil Co. on the Buell ranch, was abandoned, dry, in August at a reported depth of 4,575 feet.

Ventura County.—In the various areas of oil production in Ventura County, where relatively shallow wells of small capacity are the rule, drilling activity was fairly well sustained throughout the year. In the Bardsdale field, on the south side of Santa Clara River across from Fillmore, a number of excellent wells were completed by the Montebello Oil Co. in sec. 4, T. 3 N., R. 19 W. A deep sand reached on the Shiells lease, at depths of 2,600 to 2,900 feet, furnished wells of 250 to 300 barrels initial capacity.

In the Santa Paula district the best well of the year was drilled by the Santa Clara Oil & Development Co. in sec. 13, T. 4 N., R. 21 W. The well was completed in September at a reported depth of 3,300 feet and yielded an initial production of 70 barrels of oil that was said to average 37.9° B. in gravity and to yield on distillation 30 per cent gasoline of 60° B. gravity, about 18 per cent kerosene distillate, 18 per cent stove distillate and neutral oil, 10 per cent lubricating stock, and to contain considerable paraffin wax, though the oil is of asphaltic base.

In Simi Valley, on the north flank of the Simi Hills, the Calabasas Oil Co. completed a dry hole in sec. 22, T. 2 N., R. 18 W., at a reported depth of 2,525 feet. Better success attended the efforts of the Santa Susana Syndicate and the Petrol Oil Co., operating on the north side of Simi Valley, and three productive wells were added to the small field at the mouth of Tapo Canyon.

A betterment that will undoubtedly result in more active development of the Ventura County fields was provided in 1915 by the Ventura Refining Co., a subsidiary of the Ventura Consolidated Oil Fields, that owns or controls among others the Montebello and Oak Ridge Oil companies, in the completion of the initial unit of a modern oil refinery at Fillmore. The capacity of this unit is 20,000 barrels of crude oil a day, and the specialty of the plant is gasoline.

Los Angeles County.—Within the productive limits of the Salt Lake-Sherman field, west of Los Angeles, and of the Los Angeles City field no developments of consequence were made in 1915. In the Newhall district, in the northwestern part of Los Angeles County, drilling activity for the year resulted in two dry holes.

Near the town of Chatsworth, at the west end of San Fernando Valley, southwest of Newhall, the Placerita Oil Co., after drilling to a depth of 2,430 feet in an effort to discover oil, completed its well in July as a gas well with an estimated open flow of 1,500,000 cubic feet a day. The discovery well was capped, and to the end of the year no disposition of its production had been made. No additional wells were completed during 1915, and the importance of the discovery

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was still a matter of speculation at the beginning of 1916. A gas field of consequence in this locality would be of considerable importance, as there are a number of small towns in the vicinity where its product could be marketed profitably, and the larger markets in Pasadena and Los Angeles are only 25 to 30 miles distant.

San Diego County.—Though continued throughout 1915, work on the deep test of the Balboa Oil Co. in Mission Valley, just north of San Diego, and on the wildcat test of the Otay Oil Co. in Otay Valley, 10 miles southwest of San Diego, failed to yield conclusive results, and the wells remained uncompleted at the end of the year.

San Benito County.—Though drilled to a depth of nearly 4,000 feet without encouraging results, the test of McMurtry & Hoeppner on James Creek, in sec. 32, T. 17 S., R. 10 E., 14 miles southeast of San Benito, remained unfinished at the close of 1915.

Imperial County.—Late in September the reported occurrence of petroleum in a spring in sec. 32, T. 11 S., R. 12 E., a few miles west of Brawley and south of Salton Sink, resulted in the staking and filing of innumerable petroleum placer claims in this portion of the Colorado desert but in no actual drilling. Several years ago a number of wells were drilled for oil in this region, but nothing of importance was found.

MARKETED PRODUCTION.

Petroleum marketed in California, 1876–1915.

Year.	Production (barrels).	Percentage of total production.	Increase or decrease.		Value.	Yearly average price per barrel.
			Barrels.	Per cent.		
1876	12,000	0.13			$30,000	$2.500
1877	13,000	.10	+ 1,000	+ 8.33	32,500	2.500
1878	15,227	.10	+ 2,227	+ 17.13	35,174	2.309
1879	19,858	.10	+ 4,631	+ 30.41	45,872	2.310
1880	40,552	.15	+ 20,694	+104.21	93,675	2.309
1881	99,862	.36	+ 59,310	+146.26	230,727	2.310
1882	128,636	.42	+ 28,774	+ 28.81	297,149	2.309
1883	142,857	.61	+ 14,221	+ 11.06	330,000	2.310
1884	262,000	1.08	+ 119,143	+ 83.40	605,220	2.310
1885	325,000	1.49	+ 63,000	+ 24.46	750,750	2.310
1886	377,145	1.34	+ 52,145	+ 16.05	870,205	2.307
1887	678,572	2.39	+ 301,427	+ 79.92	1,567,501	2.310
1888	690,333	2.50	+ 11,761	+ 1.73	1,390,666	2.014
1889	303,220	.86	− 387,113	− 56.08	356,048	1.174
1890	307,360	.67	+ 4,140	+ 1.37	384,200	1.251
1891	323,600	.59	+ 16,240	+ 5.28	401,264	1.240
1892	385,049	.76	+ 61,449	+ 18.99	561,333	1.458
1893	470,179	.97	+ 85,130	+ 22.11	608,092	1.293
1894	705,969	1.43	+ 235,790	+ 50.15	823,423	1.166
1895	1,208,482	2.28	+ 502,513	+ 71.18	849,082	.703
1896	1,252,777	2.05	+ 44,295	+ 3.67	1,240,990	.991
1897	1,903,411	3.15	+ 650,634	+ 51.93	1,713,102	.900
1898	2,257,207	4.08	+ 353,796	+ 18.59	1,917,596	.850
1899	2,642,095	4.63	+ 384,888	+ 15.67	2,508,751	.950
1900	4,324,484	6.80	+ 1,682,389	+ 63.67	4,076,975	.943
1901	8,786,330	12.66	+ 4,461,846	+103.17	4,974,540	.566
1902	13,984,268	15.75	+ 5,197,938	+ 59.16	4,873,617	.348
1903	24,382,472	24.27	+10,398,204	+ 74.36	7,399,349	.303
1904	29,649,434	25.33	+ 5,266,962	+ 21.60	8,265,434	.279
1905	33,427,473	24.81	+ 3,778,039	+ 12.74	8,201,846	.245
1906	33,098,598	26.17	− 328,875	− .98	9,553,430	.289
1907	39,748,375	23.93	+ 6,649,777	+ 20.09	14,699,956	.370
1908	44,854,737	25.13	+ 5,106,362	+ 12.87	23,433,502	.523
1909	55,471,601	30.29	+10,616,864	+ 23.67	30,756,713	.554
1910	73,010,560	34.84	+17,538,959	+ 31.62	35,749,473	.490
1911	81,134,391	36.80	+ 8,123,831	+ 11.13	38,719,080	.477
1912	[a] 87,272,593	39.15	+ 6,138,202	+ 7.57	39,624,501	.454
1913	97,788,525	39.356	+10,515,932	+ 12.05	45,709,400	.467
1914	99,775,327	37.54	+ 1,986,802	+ 2.03	48,066,096	.482
1915	86,591,535	30.81	−13,183,792	− 13.21	36,558,439	.422
	827,865,094	22.89			378,305,671	.457

[a] Includes small quantity from Alaska.

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Petroleum marketed in California in 1914 and 1915.

District and county.	1914			1915		
	Quantity (barrels).	Value.	Price per barrel.	Quantity (barrels).	Value.	Price per barrel.
Coastal and southern:						
Los Angeles County—						
Los Angeles city	296,862	$153,879	$0.518	164,873	$81,011	$0.491
Newhall	127,706	97,999	.767	112,499	66,704	.593
Salt Lake-Sherman	2,058,820	1,054,189	.512	1,738,147	639,487	.368
Puente	667,504	383,611	.575	716,731	337,219	.471
Whittier						
Orange County—						
Fullerton [a]	13,260,226	8,202,968	.618	11,885,150	5,895,572	.496
Ventura County—						
Santa Paula	857,685	947,681	1.104	908,359	641,878	.707
Santa Barbara County—						
Lompoc	4,310,236	2,163,912	.502	4,272,630	1,976,384	.463
Santa Maria						
Summerland	53,561	32,692	.610	18,314	9,955	.544
Monterey County	20,751	10,637	.512	37,617	20,220	.538
San Mateo County						
San Luis Obispo County						
Santa Clara County						
San Joaquin Valley:						
Fresno County—						
Coalinga	15,692,733	7,173,559	.457	12,851,034	5,142,990	.400
Kern County—						
Kern River	6,683,592	2,589,238	.387	7,585,400	2,854,862	.376
Lost Hills	3,325,516	1,961,995	.589	3,124,082	1,365,838	.437
McKittrick [b]	5,315,638	2,054,342	.386	4,515,813	1,906,400	.422
Midway	37,862,683	17,363,080	.458	29,930,003	12,196,056	.407
Sunset	9,241,814	3,876,314	.419	8,730,883	3,423,863	.392
	62,429,243	27,844,969	.446	53,886,181	21,747,019	.411
Grand total	99,775,327	48,066,096	.482	86,591,535	36,558,439	.422

[a] Includes Coyote Hills. [b] Includes Belridge.

Petroleum marketed in California, 1906–1915, by counties, in barrels.

Year.	Fresno.	Kern.	Los Angeles.	Orange.	Santa Barbara.	Ventura.	San Mateo.	Santa Clara.	Total.
1906	7,991,039	14,520,854	3,449,119	2,032,637	4,774,361	299,124	[a] 31,464		33,098,598
1907	8,871,723	15,652,156	3,477,235	2,604,982	8,708,077	357,094	[a] 77,108		39,748,375
1908	10,386,168	18,132,893	4,692,495	3,358,714	7,816,682	379,044	[a] 88,741		44,854,737
1909	14,795,459	23,831,768	16,774,195				[a] 70,179		55,471,601
1910	18,387,750	37,896,727	16,665,678				[b] 60,405		73,010,560
1911	18,483,751	45,921,712	16,708,466				[b] 20,462		81,134,391
1912	19,911,820	50,245,255	[c] 17,095,395				[b] 20,123		87,272,593
1913	19,302,654	58,278,966	20,164,689				[b] 42,216		97,788,525
1914	15,692,733	62,429,343	3,150,892	13,260,226	4,363,797	857,685	[d] 20,751		99,775,327
1915	12,851,034	53,886,181	2,732,250	11,885,150	4,290,944	908,359	[d] 37,617		86,591,535

[a] Includes oil produced in San Luis Obispo County.
[b] Production of Santa Clara and San Luis Obispo counties.
[c] Includes small quantity from Alaska.
[d] Includes Monterey County.

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Petroleum marketed in California in 1914 and 1915, with increase or decrease.

District and county.	Marketed production (barrels).		Increase or decrease.	
	1914	1915	Barrels.	Per cent.
Coastal and southern:				
Los Angeles County—				
Los Angeles city	296,362	164,873	— 131,989	—44.46
Newhall	127,706	112,499	— 15,207	—11.91
Salt Lake-Sherman	2,058,820	1,738,147	— 320,673	—15.58
Puente, Whittier	667,504	716,731	+ 49,227	+ 7.37
Orange County—				
Fullerton [a]	13,260,226	11,885,150	— 1,375,076	—10.37
Ventura County—				
Santa Paula	857,685	908,359	+ 50,674	+ 5.91
Santa Barbara County—				
Lompoc, Santa Maria	4,310,286	4,272,630	— 37,606	— .87
Summerland	53,561	18,314	— 35,247	—65.81
San Luis Obispo County, Santa Clara County	20,751	37,617	+ 16,866	+81.28
San Joaquin Valley:				
Fresno County—				
Coalinga	15,692,733	12,851,034	— 2,841,699	—18.11
Kern County—				
Kern River	6,683,592	7,585,400	+ 901,808	+13.49
Lost Hills	3,325,516	3,124,082	— 201,434	— 6.06
McKittrick [b]	5,315,688	4,515,813	— 799,825	—15.05
Midway	37,862,683	29,930,003	— 7,932,680	—20.95
Sunset	9,241,814	8,730,883	— 510,931	— 5.53
	62,429,343	53,886,181	— 8,543,062	—13.68
Grand total	99,775,327	86,591,535	—13,183,792	—13.21

[a] Includes Coyote Hills.

[b] Includes Belridge.

Petroleum marketed, value, and average price per barrel in California, 1906–1915.

Year.	Coastal and southern.			San Joaquin Valley.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1906	22,511,893	$5,191,060	$0.231	10,586,705	$4,362,370	$0.412	33,098,598	$9,553,430	$0.289
1907	24,523,879	7,393,036	.301	15,224,496	7,306,920	.4799	39,748,375	14,699,956	.370
1908	16,335,676	9,296,743	.569	28,519,081	14,136,759	.4956	44,854,737	23,433,502	.523
1909	16,844,374	9,737,616	.578	38,627,227	21,019,097	.544	55,471,601	30,756,713	.554
1910	16,726,083	10,532,080	.629	56,284,477	25,217,393	.448	73,010,560	35,749,473	.490
1911	16,728,928	10,607,280	.904	64,405,463	28,111,800	.436	81,134,391	38,719,080	.477
1912	[a]17,115,518	[a]10,454,186	.615	70,157,075	29,170,315	.416	87,272,593	39,624,501	.454
1913	20,206,905	11,293,794	.557	77,581,620	34,435,608	.444	97,788,525	45,709,400	.467
1914	31,653,351	13,047,568	.603	78,121,976	35,018,528	.448	99,775,327	48,066,096	.482
1915	19,854,320	14,811,420	.746	66,737,215	21,747,019	.326	86,591,535	36,558,439	.422

[a] Includes small quantity from Alaska.

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FIELD REPORT.

Field report for oil industry in California in 1914 and 1915.

1914.

County and district.	Wells.					Acreage.		
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Fee.	Lease.	Total.
		Oil.	Dry.					
Fresno County	1,086	35	5	50	1,071	35,549	12,273	47,822
Kern County:								
Kern River	1,778	17	.....	38	1,757	13,407	4,864	18,271
Lost Hills	136	32	4	8	160	11,050	2,800	13,850
McKittrick	343	36	7	8	371	40,925	669	41,594
Midway	1,074	172	6	41	1,205	22,990	24,965	47,955
Sunset	369	42	7	4	407	8,058	11,377	19,435
Los Angeles County:								
Los Angeles city	386	.....	.....	8	378	152	25	177
Newhall-Puente	115	9	1	.....	124	10,146	1,169	11,315
Salt Lake-Sherman	307	8	1	3	312	2,516	779	3,295
Whittier	122	8	.....	.....	130	12,438	6,126	14,564
Monterey County	1	.....	1	1	.....	1,142	2,700	3,842
Orange County	336	70	5	10	395	9,737	14,536	24,273
San Luis Obispo County	1	4	.....	.....	5	298	180	478
San Mateo County	4	.....	.....	.....	4	.....	600	600
Santa Clara County	8	2	1	.....	5	300	6,000	6,300
Santa Barbara County:								
Lompoc-Santa Maria	289	9	2	6	292	83,514	22,393	105,907
Summerland	134	8	.....	8	134	73	5	78
Ventura County	334	60	6	12	382	96,217	17,924	114,141
Miscellaneous	.....	.....	1	.....	.....	80	1,864	1,944
	6,817	512	47	197	7,132	348,592	127,249	475,841

1915.

Fresno County	1,071	20	1	5	1,086	26,073	8,819	34,892
Kern County:								
Kern River	1,757	22	.....	15	1,764	12,595	5,040	17,635
Lost Hills	160	11	2	2	169	11,148	1,920	13,068
McKittrick	271	15	.....	.....	386	39,718	497	40,215
Midway	1,205	109	6	9	1,305	19,690	25,391	45,081
Sunset	407	11	.....	12	406	12,633	10,957	23,490
Los Angeles County:								
Los Angeles city	378	1	.....	1	378	150	35	185
Newhall-Puente	124	2	.....	.....	126	688	1,546	2,184
Salt Lake-Sherman	312	1	.....	17	296	639	779	1,418
Whittier	130	6	1	8	128	2,493	1,137	3,630
Orange County	395	48	4	9	434	10,535	10,847	21,382
Riverside County	.....	.....	1	.....	.....	85	400	485
San Luis Obispo County	5	1	.....	.....	6	6,298	120	6,418
San Mateo County	4	.....	.....	4	.....	.....	.....	.....
Santa Clara County	5	1	.....	1	5	268	6,908	6,486
Santa Barbara County:								
Lompoc-Santa Maria	292	13	1	4	301	86,868	42,392	129,260
Summerland	134	1	.....	.....	135	12	3	15
Ventura County	382	10	2	3	389	75,112	33,244	108,356
Miscellaneous	.....	.....	2	.....	.....	.....	1,212	1,212
	7,132	272	20	90	7,314	304,840	150,542	455,382

WYOMING OIL FIELD.

GENERAL STATEMENT.

A marketed output of 4,245,525 barrels of crude petroleum in Wyoming in 1915 constitutes a record for production of oil in this State 19 per cent higher than the record in 1914 and 76 per cent higher than in 1913. Of the entire output of petroleum in Wyoming since the beginning of the local industry in 1894, the output in 1915 constitutes a little more than one-third.

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The steady increase in output that is so striking a feature of the statistics of the Wyoming industry during the last four years not only reflects the westward trend of petroleum developments in the United States but indicates that the Rocky Mountain States contain potential sources of petroleum that are competent, with efficient and conservative development, to replace the declining fields in the Eastern States.

Though the policy of withdrawing from mineral entry by Executive order prospective oil lands in the public domain and reserving them for future development under more appropriate legislation than the placer act has given rise to much bitter criticism, it has nevertheless been of much benefit to the oil industry in Wyoming, for it has prevented the production of oil in excess of the available transportation and refining facilities and has protected the local industry from the disastrous effects of unrestrained development so vividly shown in the course of the industry in the Mid-Continent region during the last two years.

DEVELOPMENT.

Natrona County.—The bulk of the petroleum produced in Wyoming in 1915 came as usual from the Salt Creek field, which, with the contribution of heavy oil from the Shannon field, furnished 94 per cent of the total production.

Drilling activity in this district was slight, as the old wells were capable of supplying the needs of the refineries at Casper, and no developments of consequence were reported. The feature of this district in 1915 was the shooting of old wells, one of which, a former 10-barrel producer, responded at the reported rate of 2,400 barrels a day, though the flow declined to half that quantity within a week.

Bighorn County.—Little activity was apparent in the Greybull-Basin district until late in the year. The completion of a gusher well on a town lot within the municipal limits of Greybull furnished the incentive for an active town-lot development that resulted in the completion of 30 or more successful oil wells in the southern part of the city before the end of the year and hastened the completion of the refinery of the Greybull Refining Co. at that place.

In the northwestern part of the county a number of excellent gas wells were drilled in the Byron district, southwest of Cowley, one of which, completed in September by the Montana-Wyoming Oil Co., on the J. H. NeVille ranch, was reported as the largest gas well ever drilled in Wyoming, its open-flow capacity being estimated at 40,000,000 cubic feet a day. For several weeks this monster well ran wild, and it was not until November that the company succeeded in shutting it in. At the close of the year negotiations were under way for piping the gas from this district to Billings, Mont., 80 miles to the north.

The output of petroleum in the Bighorn County districts in 1915 was 47 per cent greater than in 1914.

Hot Springs County.—Though opened in 1914, the Grass Creek district in Hot Springs County, on the southwest side of the Bighorn Basin, did not become a factor in the statistics of oil production until 1915, when access to markets was provided by a 6-inch pipe line constructed by the Illinois Pipe Line Co. from the field to a topping

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plant at Chatham, the nearest railroad point on the Billings division of the Chicago, Burlington & Quincy Railroad.

The first oil was run through the new line in July, and after August monthly runs increased steadily to the end of the year. Drilling activity in this district extended the developed portion of the field toward the east.

Park County.—Operations in the Little Buffalo Basin and the Oregon Basin districts, where natural gas was discovered in enormous quantities in 1914, were at a standstill in 1915, the remoteness of these sources of light and power from markets of any kind effectually preventing any additional development.

The discovery and partial development of a new area of production in the northeastern part of Park County constituted the most important feature of activity in the search for oil in Wyoming in 1915. The new field occupies the crest of the Silvertip anticline, about 12 miles west of Frannie, along the Wyoming-Montana boundary. The discovery well in this field was located in sec. 1, T. 58 N., R. 100 W. sixth principal meridian, and was completed in November at a reported depth of 1,100 feet, with an initial flow estimated at 400 barrels of oil a day. A number of equally good wells were completed on this fold before the end of 1915 not only in Wyoming but across the State boundary in Carbon County, Mont., as well. Before the end of December plans were under way for a pipe line from this field to Frannie, on the Chicago, Burlington & Quincy Railroad.

Late in December drilling activity was revived in the Cody district, where 3 small oil wells were completed in 1914.

Fremont County.—The output of petroleum from the productive districts in Fremont County was increased slightly in 1915 as a consequence of a little additional drilling by the Hudson Oil Co. in the new heavy-oil field opened near Lander in 1914.

In the Pilot Butte district along Wind River, about 30 miles northwest of Riverton, drilling activity was given an impetus late in 1915 by the completion, December 17, of a productive oil well by the Hall Oil Co. Additional wells were started before the close of the year and the value of the district will undoubtedly be determined in 1916.

Other counties.—The Spring Valley district, Uinta County, was featureless, and production was less than in 1914. In the Brenning Basin, near Douglas, Converse County, no new developments of consequence were made. A wildcat test of potential importance was started in 1915 on the Rock Springs dome in Sweetwater County but had not reached a sufficient depth to constitute a test of the structure before the end of the year. In Carbon County one or more unsuccessful wildcat wells were completed in the vicinity of Rawlins.

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MARKETED PRODUCTION.

Petroleum marketed in Wyoming in 1914 and 1915, by counties, in barrels.

1914.

Month.	Bighorn.[a]	Fremont[a]	Natrona.	Uinta.[a]	Other.[b]	Total.[c]
January	8,014	2,282	188,278	1,115	173	199,862
February	8,014	2,283	151,863	1,115	173	163,448
March	8,015	2,283	218,802	1,115	174	230,389
April	8,015	2,283	288,662	1,116	174	300,249
May	8,015	2,283	364,620	1,115	174	376,207
June	8,015	2,283	209,903	1,116	174	221,491
July	8,015	2,283	275,722	1,116	174	287,310
August	8,015	2,283	366,663	1,116	174	378,251
September	8,015	2,283	375,054	1,116	175	386,643
October	8,015	2,283	362,040	1,116	175	373,629
November	8,015	2,283	331,296	1,116	175	342,885
December	8,015	2,283	288,422	1,116	175	300,011
	96,178	27,395	3,421,325	13,387	2,090	3,560,375

[a] Distribution by months not known; figures given are averages.
[b] Converse and Crook counties.
[c] See note [a].

1915.

Month.	Bighorn.	Fremont.	Natrona.	Hot Springs.	Other.[a]	Total.
January	6,171	1,971	329,363	.....	564	338,069
February	3,234	2,547	248,608	.....	541	254,930
March	4,096	2,547	347,147	.....	591	354,381
April	3,077	2,955	190,218	.....	584	196,834
May	15,358	2,837	229,206	.....	692	248,093
June	36,910	2,738	355,097	.....	619	395,364
July	41,124	2,698	329,954	19,820	586	394,182
August	6,475	2,792	425,723	1,556	619	437,165
September	5,689	2,788	359,849	4,056	574	372,956
October	6,574	2,691	426,703	16,434	592	452,994
November	8,361	548	351,135	27,944	552	388,540
December	3,914	548	378,125	28,913	522	412,022
	140,978	27,660	3,971,128	98,723	7,036	4,245,525

[a] Converse, Park, and Uinta counties.

Petroleum marketed, value, and average price per barrel in Wyoming, 1894–1915.

Year.	Quantity (barrels).	Percentage of total production.	Increase or decrease.		Value.	Average yearly price per barrel.
			Barrels.	Per cent.		
1894	2,369	.....	.....	.....	$15,920	$6.720
1895	3,455	.....	+ 1,086	+ 45.84	27,640	8.000
1896	2,878	.....	— 577	— 16.70	23,024	8.000
1897	3,650	.....	+ 772	+ 26.82	29,200	8.000
1898	5,475	.....	+ 1,825	+ 50.00	38,325	7.000
1899	5,560	.....	+ 85	+ 1.55	38,920	7.000
1900	5,450	.....	— 110	— 1.98	38,150	7.000
1901	5,400	.....	— 50	— .92	37,800	7.000
1902	6,253	.....	+ 853	+ 15.74	43,771	7.000
1903	8,960	.....	+ 2,707	+ 40.29	62,720	7.000
1904	11,542	.....	+ 2,582	+ 28.82	80,794	7.000
1905	8,454	.....	— 3,088	— 26.75	51,545	6.100
1906	[a] 7,000	.....	— 1,454	— 17.20	49,000	7.000
1907	[b] 9,339	0.005	+ 2,339	+ 33.41	21,883	2.343
1908	[b] 17,775	.01	+ 8,436	+ 90.33	27,920	1.570
1909	[b] 20,056	.01	+ 2,281	+ 12.83	34,456	1.718
1910	[b] 115,430	.05	+ 95,374	+475.54	93,536	.810
1911	[b] 186,695	.085	+ 71,265	+ 61.74	124,037	.664
1912	1,572,306	.71	+1,385,611	+742.18	798,470	.507
1913	2,406,522	.97	+ 834,216	+ 53.06	1,187,232	.493
1914	3,560,375	1.34	+1,153,853	+ 47.95	1,679,192	.472
1915	4,245,525	1.51	+ 685,150	+ 19.24	2,217,018	.522
	12,210,469	.338	.....	.....	6,720,553	.550

[a] Estimated.
[b] Includes Utah.

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FIELD REPORT.

Field report for oil industry in Wyoming in 1914 and 1915.

County.	Wells.								
		1914				1915			
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Completed.		Abandoned.	Productive Dec. 31.
		Oil.	Dry.			Oil.	Dry.		
Albany			1						
Big Horn	16	21	5		37	12	3	2	47
Converse	9	3	1	3	9			1	8
Crook	12				12				12
Douglas			1						
Fremont	21	6	3	2	25	4		1	28
Hot Springs		8	5		8	30	5	1	37
Natrona	97	45	7	6	136	16	3	1	151
Park		2			2				2
Uinta	43	3	8	10	36		1	1	35
	198	88	26	21	265	62	11	7	320

County.	Acreage.					
	1914			1915		
	Fee.	Lease.	Total.	Fee.	Lease.	Total.
Albany		9,035	9,035			
Big Horn	1,129	4,357	5,486	687	9,742	10,429
Converse	7,927	9,920	17,847	927	6,480	7,407
Crook	2,840		2,840	760	1,360	2,120
Douglas	160	2,240	2,400			
Fremont		4,380	4,380		5,600	5,600
Hot Springs		2,860	2,860	920	12,840	13,760
Natrona	1,320	15,600	16,920	1,960	15,712	17,672
Park				310	16,797	17,107
Uinta	7,960	26,360	34,320	7,600	11,800	19,400
	21,496	74,752	96,248	13,164	80,331	93,495

MONTANA.

Although Montana failed to take its place among the oil-producing States in 1915, the failure was due solely to the fact that arrangements for shipping the oil discovered in the State were not completed until after the close of the year.

The discovery referred to was in Carbon County and took place late in 1915 on the Silver Tip anticline, at the north end of the Elk Basin field opened in Wyoming in November. The credit for completing the first successful oil well in Montana is ascribed to the Ohio Oil Co.

At Havre, Hill County, in the northern part of the State, additional work was done by the Havre Natural Gas Co. in the vicinity of the successful gas wells drilled by this company in 1914.

On Big Coulee, in sec. 35, T. 5 N., R. 19 E., Musselshell County, the Seventy-nine Ranch Oil Co. is reported to have completed a barren test at a depth of 2,055 feet. Showings of gas were reported at depths of 745 and 1,040 feet and of oil at depths of 1,135 and 1,760 feet. The well was completed in sandstone of the Kootenai forma-

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tion. Another test, on Willow Creek, also in Musselshell County, in sec. 20, T. 10 N., R. 27 E., northeast of Roundup, was drilled by M. J. Scott to a reported depth of 1,675 feet and furnished an abundance of artesian water but no oil or gas.

The success of operations near the Wyoming boundary will undoubtedly lead to a thorough testing of areas of favorable geologic structure in southern Montana within the next two years.

COLORADO OIL FIELD.

GENERAL STATEMENT.

The contribution of the Colorado field to the crude-petroleum industry of the United States was derived in 1915, as in former years, chiefly from the Boulder district, in Boulder County, and the Florence district, in Fremont County, but it received a slight increment from a rejuvenated district in Garfield County, a few miles southeast of Vernal, Utah. The output of the entire field, though greater than in 1913, was 6 per cent less than in 1914. The decline of 2 per cent in the output of the Boulder district represents the normal decline of the old wells, no new wells having been completed since 1911. Though two oil wells were added in the Florence district, the new production obtained was insufficient to offset the decline of the old wells, and a 6 per cent decline resulted. In the miscellaneous districts including Rangely, De Beque, and Garfield County, where oil is generally produced only when additional drilling is under way, the lack of activity in 1915 is responsible for the decline of 96 per cent.

In apparent sympathy with the depressed markets for petroleum in the eastern fields, prices of crude oil in the Colorado field were lower in 1915 than in any year since 1907, when the average yearly price was 82 cents a barrel. In 1915 it was 88 cents a barrel, a decrease of 2 cents from the average in 1914.

No new wells were drilled in the De Beque district in 1915, and the only well capable at the beginning of the year of producing small quantities of oil was abandoned.

At Rangely one well was completed and capped and one well was abandoned.

Late in the fall a test was started 6 miles north of Hotchkiss, Delta County, in a locality where, for a number of years, gas has been observed escaping from shale that crops out on the southern flank of Grand Mesa.

Unsuccessful wildcat tests remote from oil development were completed east of Denver, in Adams County, near Fowler, in Crowley County, and near Mosca, in Alamosa County.

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MARKETED PRODUCTION.

Petroleum marketed in Colorado in 1914 and 1915, by districts in barrels.

Month.	1914				1915			
	Boulder.	Florence.	Other.[a]	Total.	Boulder.	Florence.	Other.	Total.
January	880	15,757	59	16,696	901	17,381	.....	18,282
February	594	14,910	59	15,563	545	15,213	.....	15,758
March	472	15,905	59	16,436	579	15,738	.....	16,317
April	518	17,409	59	17,986	688	17,386	.....	18,024
May	575	17,271	59	17,905	478	14,549	.....	15,027
June	433	17,312	59	17,804	442	13,580	.....	14,022
July	520	19,355	59	19,934	596	16,726	.....	17,322
August	370	20,124	59	20,553	501	14,098	.....	14,599
September	588	19,182	59	19,829	210	15,697	.....	15,907
October	488	20,098	59	20,645	571	16,125	.....	16,696
November	695	19,124	59	19,888	454	20,603	.....	21,056
December	382	19,091	61	19,534	461	24,974	.....	25,435
	6,515	215,548	710	222,773	6,376	202,069	30	208,475
Decrease in 1915:								
Barrels	.....	.....	.....	.....	139	13,479	680	14,298
Per cent	.....	.....	.....	.....	2.13	6.25	95.77	6.42

[a] Averaged.

Petroleum marketed, value, and average price per barrel in Colorado, 1887–1915.

Year.	Quantity (barrels).	Percentage of total production.	Increase or decrease.		Value.	Average yearly price per barrel.
			Barrels.	Per cent.		
1887	76,295	0.27	.....	.....	$76,295	$1.000
1888	297,612	1.07	+ 221,317	+ 29.01	267,851	.900
1889	316,476	.90	+ 18,864	+ 6.34	280,240	.885
1890	368,842	.80	+ 52,366	+ 16.54	309,827	.840
1891	665,482	1.22	+ 296,640	+ 80.42	559,005	.840
1892	824,000	1.63	+ 158,518	+ 23.82	692,160	.840
1893	594,390	1.22	− 229,610	− 27.86	497,581	.838
1894	515,746	1.05	− 78,644	− 13.23	303,652	.589
1895	438,232	.83	− 77,514	− 15.02	336,010	.767
1896	361,450	.59	− 76,782	− 17.52	318,977	.883
1897	384,934	.64	+ 23,484	+ 6.50	332,122	.863
1898	444,383	.80	+ 59,449	+ 15.44	367,447	.827
1899	390,278	.69	− 54,105	− 12.18	404,110	1.035
1900	317,385	.50	− 72,893	− 18.67	323,434	1.019
1901	460,520	.66	+ 143,135	+ 45.09	461,031	1.000
1902	396,901	.45	− 63,619	− 13.81	484,683	1.220
1903	483,925	.48	+ 87,024	+ 21.93	431,723	.892
1904	501,763	.48	+ 17,838	+ 3.67	578,035	1.152
1905	376,238	.28	− 125,525	− 25.02	337,606	.897
1906	327,582	.26	− 48,656	− 12.93	262,675	.802
1907	331,851	.20	+ 4,269	+ 1.30	272,813	.822
1908	379,653	.21	+ 47,802	+ 14.40	346,403	.913
1909	310,861	.17	− 68,792	− 18.12	318,162	1.023
1910	239,794	.12	− 71,067	− 22.86	243,402	1.015
1911	226,926	.10	− 12,868	− 5.37	228,104	1.005
1912	206,052	.09	− 20,874	− 9.20	199,661	.973
1913	188,799	.07	− 17,253	− 8.37	174,779	.926
1914	222,773	.09	+ 33,974	+ 17.99	200,894	.902
1915	208,475	.075	− 14,298	− 6.42	183,485	.880
	10,857,618	.30	.....	.....	9,792,107	.902

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Petroleum marketed, value, and average price per barrel in Colorado, 1906–1915, by districts.

Year.	Boulder.			Florence.			Total.		
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.	Average price per barrel.
1906.....	48,952	$53,847	$1.0999	278,630	$208,828	$0.7495	327,582	$262,675	$0.802
1907.....	68,353	75,188	1.0999	263,498	197,625	.750	331,851	272,813	.822
1908.....	84,174	124,794	1.483	295,479	221,609	.750	379,653	346,403	.913
1909.....	85,709	129,812	1.514	295,062	187,900	.634	[a] 310,861	318,162	1.023
1910.....	42,186	63,490	1.508	193,482	174,332	.901	[b] 239,794	243,402	1.015
1911.....	37,973	50,393	1.327	167,341	175,763	.968	[b] 236,926	226,104	1.095
1912.....	15,304	19,130	1.250	190,498	180,281	.946	[c] 205,052	199,661	.973
1913.....	11,796	15,366	1.303	176,693	159,103	.900	[c] 188,799	174,779	.926
1914.....	6,515	9,117	1.399	215,548	191,067	.886	[d] 222,773	200,894	.902
1915.....	6,376	9,679	1.518	202,069	173,506	.859	[c] 208,475	183,485	.880

[a] Includes a small production in Garfield County.
[b] Includes production in Garfield and Rio Blanco counties.
[c] Includes production in Rio Blanco County.
[d] Includes production in Mesa and Rio Blanco counties.

FIELD REPORT.

Field report for oil industry in Colorado in 1914 and 1915.

County.	Wells.								
	1914					1915			
	Productive Jan. 1.	Completed.		Abandoned.	Productive Dec. 31.	Completed.		Abandoned.	Productive Dec. 31.
		Oil.	Dry.			Oil.	Dry.		
Adams							1		
Boulder	18			4	14				14
Crowley			1				1		
El Paso			1						
Fremont	51	11	8	6	56	2	4	3	55
Garfield	1				1				1
Mesa		1			1			1	
Rio Blanco	23				23	1		1	23
	93	12	10	10	95	3	6	5	93

County.	Acreage.					
	1914			1915		
	Fee.	Lease.	Total.	Fee.	Lease.	Total.
Adams						
Boulder	2,599	95	2,694	2,511	215	2,726
Crowley		2,600	2,600	1,600	1,000	2,600
El Paso		8,000	8,000			
Fremont	8,806	17,470	26,276	8,330	17,480	25,810
Garfield	320		320	320		320
Mesa	300		300	300	307	607
Rio Blanco	5,360		5,360	4,640		4,640
	17,385	28,165	45,550	17,701	19,092	36,793

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UTAH OIL FIELD.

DEVELOPMENT.

One oil well, capacity not reported, was completed in the San Juan field, San Juan County, in 1915. This is the sixth well in which oil has been found in this field. No commercial production was reported, however, as the area is remote from transportation facilities and difficult of access. The capacity of the successful wells drilled thus far in this field has not been sufficient to attract the capital necessary to finance a project for marketing the product.

Additional work in 1915 near Fillmore, Millard County, in the western part of the State failed to develop oil in commercial quantities.

Considerable interest is now being taken in Utah in the possibilities of commercial development of the oil shale deposits of the Wasatch plateau in the northeastern part of the State. A company known as the Utah Oil Shale Products Co. has been organized, and steps have been taken toward the erection of a plant in Kyune Canyon, near Colton, Utah County.

FIELD REPORT.

Field report for oil industry in Utah in 1914 and 1915.

County.	Wells.								
	1914					1915			
	Productive Jan. 1.	Completed. Oil.	Completed. Dry.	Abandoned.	Productive Dec. 31.	Completed. Oil.	Completed. Dry.	Abandoned.	Productive Dec. 31.
San Juan	5	.....	1	.....	5	1	.....	.....	6
Uinta	1	.....	.....	1	.....	.....	.....	.....	.....
Washington	3	.....	.....	3	.....	.....	.....	.....	.....
	9	.....	1	4	5	1	.....	.....	6

County.	Acreage.					
	1914			1915		
	Fee.	Lease.	Total.	Fee.	Lease.	Total.
San Juan	13,417	1,680	15,097	16,257	.....	16,257
Uinta	1,300	.....	1,300	.....	.....	.....
Washington	.....	.....	.....	.....	.....	.....
	14,717	1,680	16,397	16,257	.....	16,257

MICHIGAN, MISSOURI, AND ALASKA.

GENERAL STATEMENT.

The petroleum produced in Michigan in 1915, which consisted, as in previous years, of natural lubricating oil from a few wells near Port Huron, St. Clair County, was materially increased as a consequence of more active field operations. Wells in this locality derive their oil from a sand encountered at an average depth of 650 feet, and although the initial production rarely exceeds five barrels a day the value of the oil and the low cost of obtaining it render its development profitable.

In Missouri commercial production of petroleum is at present restricted to Jackson County. The influence on the oil industry in Missouri of the successful development of new areas of production in Kansas is already apparent, and a number of tests have been

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proposed for the counties along the Kansas boundary. In 1915 the Tarkio Oil & Gas Co. completed a salt-water test at a reported depth of 1,350 feet within the city limits of Tarkio, Atchison County, and Burr & Glazier completed a barren test at a total depth of 1,060 feet after penetrating the "Mississippi lime" to a depth of 600 feet, near Excelsior Springs, Clay County. At the end of the year tests were under way north of Tarkio, Atchison County; near Pacific, Jackson County; near Nevada, Vernon County; and near Boonville, Cooper County.

Brooks [1] describes the status of petroleum developments in Alaska in 1915 as follows:

There were no important developments in the Alaska oil fields during 1915. The company which has been producing oil and making gasoline at Katalla went into the hands of a receiver and was reorganized. Operations were, however, not interrupted, and the production of crude petroleum and gasoline was continued as in previous years. According to current reports an oil seepage was discovered in northern Alaska near Wainright Inlet, about 100 miles southwest of Point Barrow. If this report is confirmed, it is probably a western extension of the oil field occurring southwest of Smith Bay.

As the Alaska petroleum is a refining oil similar to that of Pennsylvania and has a high percentage of volatile compounds, the present market conditions would seem to justify the systematic prospecting of the more accessible fields of the Territory. No doubt if the fields are opened by a leasing law, as is now under consideration, this work will be undertaken. Meanwhile large quantities of petroleum and petroleum products are annually shipped to Alaska.

MARKETED PRODUCTION.

Petroleum marketed in Missouri, 1889–1915.

Year.	Quantity (barrels).	Percentage of total production.	Increase or decrease.		Value.	Average yearly price per barrel.
			Barrels.	Per cent.		
1889	20	.....	.....	.....	$40	$2.000
1890	278	.....	+ 258	+1,290.00	556	2.000
1891	25	.....	− 253	− 91.01	84	3.360
1892	10	.....	− 15	− 60.00	40	4.000
1893	50	.....	+ 40	+ 400.00	154	3.080
1894	8	.....	− 42	− 84.00	40	5.000
1895	10	.....	+ 2	+ 25.00	50	5.000
1896	43	.....	+ 33	+ 330.00	185	4.300
1897	19	.....	− 24	− 55.81	174	9.158
1898	10	.....	− 9	− 47.37	105	10.500
1899	132	.....	+ 122	+1,220.00	205	1.553
1900	[a] 1,602	.....	+ 1,470	+1,113.64	1,177	.735
1901	[a] 2,335	.....	+ 733	+ 45.76	2,600	1.114
1902	[a] 757	.....	− 1,578	− 67.58	1,066	1.408
1903	[a] 3,000	.....	+ 2,243	+ 296.30	4,650	1.550
1904	[a] 2,572	.....	− 428	− 14.27	4,769	1.854
1905	[a] 3,100	.....	+ 528	+ 20.53	3,320	1.071
1906	[a] 3,500	.....	+ 400	+ 12.90	4,890	1.397
1907	[a] 4,000	.....	+ 500	+ 14.28	6,500	1.625
1908	[a] 15,246	.....	+11,246	+ 281.15	22,345	1.466
1909	[a] 5,750	.....	− 9,496	− 62.28	7,830	1.362
1910	[a] 3,615	.....	− 2,135	− 37.13	4,794	1.326
1911	[a] 7,995	.....	+ 4,380	+ 121.16	7,995	1.000
1912	[b]	.....	.....	.....	.....	.....
1913	[c] 10,843	0.004	+10,843	.....	19,263	1.777
1914	[d] 7,792	.....	− 3,051	− 28.14	14,291	1.834
1915	[d] 14,265	.005	+ 6,473	+ 83.07	24,295	1.703
	86,977	.002	.....	.....	131,418	1.511

[a] Includes Michigan.
[b] No production for Missouri; Michigan included in Lima, Ohio.
[c] Includes Alaska, Michigan, and New Mexico.
[d] Includes Alaska and Michigan.
[1] Brooks, A. H., Mineral resources of Alaska in 1915: U. S. Geol. Survey Bull. 642, p. 52, 1916.

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OTHER STATES.

Arizona.—In Tonto Basin, Gila County, the test well started in 1914 was drilled to a reported depth below 2,000 feet without encountering significant indications of oil or gas. Late in the year work was reported to have been resumed at 1,700 feet by the Verde Valley Oil Co. on its test near Verde, which has been idle for more than a year.

Arkansas.—The successful development of abundant supplies of natural gas in the vicinity of Fort Smith and Van Buren has led to the drilling of many tests for oil in different parts of Arkansas. Efforts in this direction have, however, thus far proved unsuccessful. Uncompleted wildcat tests for oil in Arkansas were reported as follows at the close of 1915:

Logan County: Paris Oil & Mineral Co., sec. 36, T. 8 N., R. 26 W.; idle at 1,750 feet.
Jefferson County: Jefferson Oil Co., sec. 33, T. 8 S., R. 26 W.; 4 miles southeast of Pine Bluff; depth unknown.
Polk County: Grawniss Oil & Gas Co., sec. 28, T. 6 S., R. 32 W.; rig built.
Howard County: Perpetual Oil & Gas Co., sec. 29, T. 9 S., R. 27 W.; depth, 740 feet.
Sevier County: Wilson and others, sec. 28, T. 8 S., R. 32 W., near De Queen; depth, 400 feet.
Hempstead County: Hope Waterworks, sec. 12, T. 12 S., R. 24 W.; depth, 1,950 feet.
Crawford County: Clear Creek Oil & Gas Co.; depth and location not available.
Independence County: C. W. Ross and others, sec. 14, T. 13 N., R. 5 W.; idle at 1,900 feet.
Sulphur Rock Development Co., near Sulphur Rock; idle at 1,190 feet.

Florida.—Drilling was continued near Kissimmee, Osceola County, by the Pennsylvania Oil Co. in 1915, the well being reported at a depth below 2,500 feet at the close of the year.

Maryland.—A wildcat test was started in 1915 by the Isle of Wight Oil Co., on the Isle of Wight, Worcester County, on the eastern shore of Maryland.

Mississippi.—Near Meridian, Lauderdale County, two tests drilled during 1915 were reported abandoned, dry, at depths of 2,500 feet; and in Jefferson County, west of Fayette, the test of the Truly Lake Oil Co. was equally unsuccessful.

New Mexico.—In McKinley County a test well was drilled by Humphreys & Whiteside in the San Juan Basin, 50 miles northwest of Albuquerque. The well is reported to have yielded a copious flow of salt water from a depth of 1,100 feet and to have been abandoned in October, 1915.

Washington.—Efforts to obtain oil in commercial quantities in Washington were unsuccessful, and the enthusiastic drilling campaign inspired by the alleged discovery of oil in Thurston County in 1914 proved to be only temporary.

IMPORTS.

Imports of crude petroleum for consumption in the United States in 1915 were nearly 1,000,000 barrels greater than in 1914, though the declared value was more than $1,000,000 less. As practically all the crude petroleum imported by the United States comes from Mexico, the increased quantity reflects the expansion of domestic markets for fuel oil and for oil asphalt, the principal products of

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Mexican petroleum. The decreased value, on the other hand, reflects the conditions of overproduction of petroleum in this country that necessitated lower prices for oils entering United States ports in competition with the domestic supply.

Importations of paraffin oil and of the various types of paraffin wax were decidedly less in 1915 than in other recent years.

Petroleum, paraffin oil, and ozokerite and paraffin wax imported for consumption in the United States, 1911–1915.

Year.	Petroleum.		Paraffin oil.		Ozokerite and paraffin wax.		Total value.
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (pounds).	Value.	
1911	1,709,932	$2,410,884	4,019	$43,343	12,699,459	$749,475	$3,203,702
1912	7,383,229	6,082,881	2,571	32,565	17,617,068	985,959	7,101,405
1913	17,809,058	12,947,280	3,676	49,458	16,051,322	932,894	13,929,632
1914	17,247,483	11,465,466	2,481	36,687	15,516,242	824,234	12,326,387
1915	18,140,110	10,389,012	1,707	85,121	10,259,445	553,397	11,027,530

Gross imports of petroleum and petroleum products into the United States in 1914 and 1915.

Kind and source.	1914		1915	
	Quantity.	Value.	Quantity.	Value.
Crude petroleum:	*Gallons.*		*Gallons.*	
Canada	858	$41	15,159	$713
Mexico	682,330,948	9,363,690	734,095,539	9,760,859
Trinidad and Tobago	9,023,024	183,351	12,248,825	281,729
Panama			186,259	2,217
Peru	18,994,284	475,755	15,254,994	405,807
Argentina			1,678	56
England	200	10		
Germany	1,753	250		
China			85	2
Hongkong			1,350	20
Japan			45,000	1,150
	710,351,077	10,023,097	761,852,180	10,387,553
Benzine, gasoline, and naphtha:				
Canada	2,922	486	2,188	321
Mexico	850	101	1,134,080	34,301
Peru	7,551,830	497,350		
England			10,410	4,134
Straits Settlements	5,195,677	622,696		
	12,751,279	1,120,633	1,146,678	38,756
Mineral wax (ozokerite and ceresine):	*Pounds.*		*Pounds.*	
Canada	607,646	11,587	6,542	1,434
England	611,072	29,577	573,931	42,703
Austria-Hungary	563,867	82,837	285,115	42,595
Germany	4,143,378	276,325	1,579,057	105,868
Netherlands	89,507	5,121	104,314	5,930
Belgium	20,166	1,388		
Denmark			4,255	264
China	112,000	4,459		
British India	586,331	27,116	276,448	12,436
Dutch East Indies	44,800	1,895		
British East Indies	33,500	1,697		
British South Africa			15,642	3,265
	6,812,270	442,030	2,845,304	214,495
Paraffin wax:				
Canada			168,597	5,567
Austria-Hungary	1,623,723	68,845		
Belgium	54,466	4,380		
Germany	164,107	8,525	131	21
Netherlands	916,759	39,588	192,500	8,212
England	3,559,604	169,819	990,897	49,786
Scotland	55,600	1,577	13,440	681
China			224,000	10,464
British India	1,123,350	51,445	2,825,970	130,095
Dutch East Indies	1,026,205	41,134	2,997,093	135,567
	8,523,814	385,313	7,412,628	340,393

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EXPORTS.

TERRITORIAL SHIPMENTS.

The market for petroleum and its products in Alaska has greatly expanded in the last decade, as is shown by the following statistical summary compiled from the records of the Bureau of Foreign and Domestic Commerce:

Petroleum products shipped to Alaska from other parts of the United States, 1906–1915.

Year.	Oil used for fuel, including crude, gas oil, and residuum.		Gasoline, including all lighter products of distillation.		Illuminating.		Lubricating.	
	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.
1906	2,688,940	$38,499	580,978	$100,694	568,033	$109,964	83,992	$32,854
1907	9,104,300	143,506	636,881	119,345	510,145	99,342	100,145	37,929
1908	11,891,375	176,483	939,424	147,104	566,598	102,567	94,542	36,423
1909	14,119,102	340,225	746,930	118,810	531,727	98,786	85,687	35,882
1910	19,143,091	506,200	788,154	136,569	626,972	95,483	104,512	38,625
1911	20,878,843	485,279	1,238,865	167,915	423,750	57,896	100,141	34,048
1912	15,523,555	309,804	2,736,739	344,739	672,176	100,722	154,565	60,949
1913	15,683,412	453,756	1,735,658	272,661	661,656	106,603	150,918	61,966
1914	18,601,384	404,349	2,878,723	373,607	731,146	103,779	191,878	74,535
1915	16,910,012	476,564	2,413,962	243,712	513,075	82,105	271,981	101,988

Petroleum products shipped to Hawaii, the Philippines, and Porto Rico, 1906–1915.

Year.	Oil used for fuel, including crude, gas oil, and residuum.		Gasoline, including all lighter products of distillation.		Illuminating.		Lubricating.	
	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.
HAWAII.								
1906	38,883,100	$871,830	550,975	$71,954	1,225,864	$199,443	241,567	$76,134
1907	38,916,400	581,905	484,435	73,405	1,441,637	230,968	355,451	104,930
1908	47,719,000	802,325	648,310	91,851	1,143,591	179,507	358,262	140,157
1909	43,764,041	871,485	804,169	127,076	1,401,381	232,340	307,831	121,282
1910	54,539,511	1,095,549	974,268	160,700	1,359,671	226,481	359,528	133,968
1911	47,250,018	949,409	1,329,589	203,052	1,587,873	220,505	466,826	138,927
1912	58,790,343	1,182,230	2,501,938	343,062	1,817,718	190,939	477,012	165,993
1913	60,066,083	1,154,188	2,058,091	315,333	1,807,288	210,997	456,477	145,455
1914	67,893,460	1,207,036	3,162,667	364,260	2,157,021	250,158	408,606	147,243
1915	72,795,031	1,256,003	3,546,351	379,134	1,966,448	227,212	569,032	193,821
PHILIPPINES.								
1906	7,360	442	40,450	6,482	4,412,398	398,706	195,006	39,887
1907	.....	.....	79,560	12,930	8,218,400	842,111	181,504	32,598
1908	4,594	322	140,550	21,775	9,234,263	957,284	257,800	61,571
1909	21,789	1,581	184,390	23,428	5,995,000	558,642	362,068	81,278
1910	13,703	1,122	318,070	42,058	10,643,804	862,496	432,867	95,213
1911	5,502	376	1,074,615	158,792	11,653,570	913,760	470,832	107,499
1912	106,872	5,358	1,326,040	216,810	12,634,519	1,094,596	487,607	121,999
1913	10,370	1,013	1,414,225	280,090	12,091,810	1,142,403	517,494	105,001
1914	11,408	564	1,197,774	206,754	12,906,403	1,219,404	971,977	189,279
1915	12,427	366	1,483,534	241,273	8,524,833	731,028	784,192	157,925
PORTO RICO.								
1906	16,585	1,224	79,841	17,786	1,315,589	151,013	196,732	41,777
1907	.....	.....	219,691	38,003	1,700,838	176,808	223,389	53,599
1908	25,437	2,118	285,188	45,479	1,623,477	189,021	264,012	65,776
1909	7,566	475	495,367	93,649	1,931,676	216,316	218,829	78,963
1910	8,739	499	874,814	135,290	1,973,369	222,108	238,935	91,356
1911	51,556	2,899	1,106,327	133,470	2,323,401	207,804	479,579	117,034
1912	29,204	1,857	1,470,105	223,325	2,168,105	212,043	471,596	134,882
1913	21,108	1,439	1,580,772	303,012	2,381,187	246,137	507,412	120,007
1914	53,586	4,939	1,836,896	320,163	2,227,195	227,500	361,117	80,247
1915	65,447	3,337	2,401,695	449,044	2,426,133	219,148	391,245	88,081

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FOREIGN SHIPMENTS.

The foreign trade of the United States in petroleum and its liquid products in the calendar year 1915 showed a gain of 4 per cent in quantity and of 2 per cent in declared value over that in 1914. Quantity losses sustained in exports of illuminating oils were more than offset by corresponding gains in exports of naphtha and gasoline, crude oil, lubricating and paraffin oils, and residuum.

Foreign shipments of petroleum and its liquid products from the United States in 1915 amounted in value to $142,941,669. Imports for consumption of petroleum and its liquid products were valued at $10,474,133, leaving a trade balance of $132,467,536 in favor of the American petroleum industry, exclusive of the trade in the solid and semisolid products of petroleum (waxes, greases, and oil asphalt).

The following tables have been compiled from the records of the Bureau of Foreign and Domestic Commerce:

Mineral oils exported from the United States in 1914 and 1915, by months.

Month.	1914		1915	
	Quantity (gallons).	Value.	Quantity (gallons).	Value.
January	163,890,375	$10,608,233	148,372,606	$8,872,086
February	151,251,958	10,011,456	152,997,597	9,232,563
March	173,095,529	11,544,113	168,396,821	10,750,210
April	221,052,913	14,641,651	170,811,299	11,407,548
May	196,196,201	12,860,072	218,420,565	13,133,539
June	217,744,327	13,387,524	211,479,373	13,449,791
July	231,745,397	14,155,736	217,383,156	12,913,406
August	147,667,507	7,990,191	233,444,401	14,069,644
September	203,460,460	13,047,539	215,623,617	12,421,784
October	195,883,472	12,391,489	205,323,026	11,467,090
November	169,995,910	9,713,612	187,871,972	12,571,643
December	168,109,608	9,548,971	198,601,316	12,652,365
	2,240,033,652	139,900,587	2,328,725,749	142,941,669

Mineral oils exported from the United States in 1914 and 1915, by kinds and ports.

Kind and port.	1914		1915	
	Quantity.	Value.	Quantity.	Value.
CRUDE.	*Barrels.*		*Barrels.*	
New York	507,799	$1,667,949	216,519	$673,581
Philadelphia				
Galveston			13	30
Other districts	2,462,095	3,290,889	3,551,636	3,609,216
	2,969,894	4,958,838	3,768,168	4,282,827
NAPHTHA.	*Gallons.*		*Gallons.*	
Baltimore	52,218	6,478	35,539	4,167
Boston and Charlestown	30,182	4,634	63,552	10,672
New York	104,489,412	14,053,210	160,512,887	20,716,994
Philadelphia	24,284,157	2,786,555	25,588,526	2,950,289
Galveston	42,225	5,555	45,447	5,637
Other districts	80,794,461	8,431,982	95,363,130	10,197,288
	209,692,655	25,288,414	281,609,081	33,885,047
ILLUMINATING.				
Baltimore	900,124	57,000	191,565	15,437
Boston and Charlestown	88,246	9,742	89,556	10,207
New York	467,633,204	34,736,938	409,872,429	27,649,700
Philadelphia	142,498,871	9,029,794	101,787,388	5,415,300
Galveston	20,000	2,125	90,000	8,550
Other districts	399,308,808	20,277,173	324,927,727	16,889,403
	1,010,449,253	64,112,772	836,958,665	49,988,597

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Mineral oils exported from the United States in 1914 and 1915, by kinds and ports—Continued.

Kind and port.	1914		1915	
	Quantity.	Value.	Quantity.	Value.
LUBRICATING AND PARAFFIN.				
	Barrels.		*Barrels.*	
Baltimore	8,135,368	1,164,547	6,038,137	746,444
Boston and Charlestown	102,923	21,058	306,457	52,531
New York	139,412,476	18,822,914	165,782,388	23,271,302
Philadelphia	29,468,223	3,587,246	51,935,306	5,604,446
Galveston	268,076	51,859	70,513	11,461
Other districts	14,260,504	2,668,679	15,545,924	2,773,457
	191,647,570	26,316,313	239,678,725	32,459,641
RESIDUUM.				
Baltimore	1,424,281	42,894	2,150,663	61,461
Boston and Charlestown	105,550	4,780	5,632	261
New York	108,433,079	3,817,903	101,860,915	3,099,229
Philadelphia	18,622,616	846,572	22,292,058	729,228
Galveston			50	3
Other districts	579,923,095	14,512,101	685,906,891	18,435,375
	703,508,621	19,224,250	812,216,209	22,325,557
Grand total	2,240,033,652	139,900,587	2,328,725,749	142,941,669

Recapitulation by kinds.

	Gallons.		*Gallons.*	
Crude	124,735,553	$4,958,838	158,263,069	$4,282,827
Naphtha	209,892,655	25,288,414	281,609,081	33,885,047
Illuminating	1,010,449,253	64,112,772	836,958,665	49,988,597
Lubricating and paraffin	191,647,570	26,316,313	239,678,725	32,459,641
Residuum	703,508,621	19,224,250	812,216,209	22,325,557
	2,240,033,652	139,900,587	2,328,725,749	142,941,669

Recapitulation by ports.

	Gallons.		*Gallons.*	
Baltimore	10,511,991	$1,270,919	8,415,904	$827,509
Boston and Charlestown	326,901	40,224	465,197	73,671
New York	836,295,729	73,098,914	847,122,431	75,410,806
Philadelphia	214,873,867	16,250,167	201,603,278	14,699,263
Galveston	330,301	59,539	206,530	25,681
Other districts	1,177,694,863	49,180,824	1,270,912,409	51,904,739
	2,240,033,652	139,900,587	2,328,725,749	142,941,669

Mineral oils exported from the United States in 1914 and 1915, by kinds and destinations.

Kind and destination.	1914		1915	
	Quantity.	Value.	Quantity.	Value.
CRUDE.				
North America:	*Barrels.*		*Barrels.*	
Canada	1,508,482	$1,840,164	2,597,544	$2,105,815
Mexico	219,227	326,124	241,254	353,583
Panama	3	6	55,427	37,004
Cuba	194,736	482,504	234,219	606,437
South America:				
Chile	173,118	131,250	32,590	27,018
Europe:				
France	244,869	626,262	17,177	18,087
Spain	272,745	976,310	100,004	452,650
Other Europe	55,042	74,834	99,556	151,775
Other countries	301,672	501,384	330,397	530,458
	2,969,894	4,958,838	3,768,168	4,282,827

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Mineral oils exported from the United States in 1914 and 1915, by kinds and destinations—Continued.

Kind and destination.	1914		1915	
	Quantity.	Value.	Quantity.	Value.
REFINED.				
Gasoline.				
North America:	*Gallons.*		*Gallons.*	
Canada	33,457,063	$3,164,696	33,874,220	$2,883,438
South America:				
Argentina	11,785,439	1,982,213	10,348,542	1,562,184
Brazil	3,221,967	567,512	7,593,380	1,198,053
Europe:				
Belgium	2,688,528	322,714		
France	32,367,031	3,866,985	14,356,497	1,515,542
Germany	3,753,361	464,410		
Italy	7,164,733	738,458	3,651,600	415,422
Netherlands	5,513,450	619,180	535,911	64,320
United Kingdom	36,023,611	3,814,309	18,928,206	1,936,089
Other Europe	7,504,190	1,025,996	5,619,013	696,016
British Oceania	6,519,747	1,223,967	8,163,752	1,313,651
Other countries	12,670,918	2,107,173	9,491,808	1,579,443
	162,669,038	19,897,613	112,562,929	13,164,159
Naphtha.				
All countries	47,023,617	5,390,801	169,046,152	20,720,888
	209,692,655	25,288,414	281,609,081	33,885,047
ILLUMINATING OIL.				
North America:				
Canada	7,898,165	548,893	6,292,171	344,099
Cuba	136,654	17,893	242,761	25,808
West Indies	6,787,871	774,551	6,024,079	636,269
South America:				
Argentina	13,601,695	1,474,306	15,408,268	1,551,437
Brazil	27,360,874	2,585,155	34,734,254	2,900,468
Chile	7,809,919	861,603	5,093,975	460,980
Other South America	9,923,509	1,150,935	11,970,999	1,205,250
Europe:				
Belgium	129,109,083	1,508,238		
Denmark	34,449,970	2,014,869	28,583,368	1,309,997
France	63,140,502	3,973,433	77,630,112	4,211,725
Germany	39,358,058	2,116,235		
Italy	31,688,719	1,644,868	30,398,605	1,490,456
Netherlands	137,593,350	6,827,422	60,078,821	2,598,088
Sweden	25,604,742	1,679,653	26,316,321	1,272,394
United Kingdom	156,754,206	7,838,262	161,901,460	7,802,883
Other Europe	36,695,402	2,272,245	46,868,634	2,709,464
Asia:				
China	91,430,759	6,432,571	84,866,476	5,034,713
British India	28,557,294	2,209,516	31,142,291	2,014,490
Hongkong	26,586,208	1,546,643	14,467,706	733,426
Japan	107,818,222	5,384,331	61,208,219	3,210,433
Oceania:				
Dutch East Indies	12,886,767	1,263,811	11,269,844	907,973
British Oceania	29,097,258	2,846,354	36,797,957	3,352,540
Philippine Islands	12,906,403	1,219,404	8,524,333	731,026
British Africa	15,311,124	1,553,775	14,831,586	1,378,750
Other countries	57,942,409	4,377,806	62,305,925	106,039
	1,010,449,253	64,112,772	836,958,665	49,968,597
LUBRICATING AND PARAFFIN OIL.				
North America:				
Canada	6,348,537	968,065	5,715,496	831,206
Mexico	694,436	153,479	745,739	184,678
Cuba	1,566,116	500,043	1,888,835	589,323
South America:				
Argentina	3,093,143	617,354	5,073,168	899,288
Brazil	2,767,220	606,578	3,898,928	729,009
Chile	1,533,375	286,935	2,037,617	343,959
Europe:				
Belgium	8,925,907	1,129,573		
France	20,637,262	2,968,840	38,744,744	4,724,157
Germany	10,733,165	1,507,696		
Italy	10,745,072	1,512,565	23,200,173	2,921,746
Netherlands	14,219,051	1,542,203	6,469,414	799,510
United Kingdom	63,411,439	7,072,143	87,672,667	10,544,686
Other Europe	13,443,281	1,936,010	29,028,538	4,065,469

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Mineral oils exported from the United States in 1914 and 1915, by kinds and destinations—Continued.

Kind and destination.	1914		1915	
	Quantity.	Value.	Quantity.	Value.
LUBRICATING AND PARAFFIN OIL—continued.				
Asia:				
Japan	3,149,380	$561,288	3,198,906	$575,287
Oceania:				
British East Indies	10,818,024	1,493,027	11,901,180	1,607,393
British Oceania	6,863,340	1,098,704	6,364,060	1,054,157
British Africa	2,060,604	435,298	2,634,415	554,042
Other countries	10,638,218	1,931,512	11,104,845	2,035,641
	191,647,570	26,316,313	239,678,725	32,459,641
GAS OIL AND FUEL OIL.[a]				
All countries	634,298,844	18,019,333	799,589,047	21,961,176
RESIDUUM, INCLUDING TAR.				
All countries	69,209,777	1,204,917	16,627,162	364,381
Total refined	2,115,296,099	134,941,749	2,170,462,680	138,658,842
Total crude and refined	2,240,033,652	139,900,587	2,328,725,749	142,941,609

[a] Does not include fuel or bunker oil in vessels engaged in the foreign trade, which aggregated in 1915 some 3,565,895 barrels, valued at $3,161,341.

Petroleum exported from Texas in 1914 and 1915.

1914.

Customs district.	Crude, including all natural oils.			Naphtha.		Illuminating.	
	Quantity.		Value.	Quantity.	Value.	Quantity.	Value.
	Barrels.	*Gallons.*		*Gallons.*		*Gallons.*	
Laredo				23,868	$2,767	247,648	$21,056
Galveston				42,225	5,555	20,000	2,125
Sabine	101,405	4,259,021	$141,408	25,995,937	2,649,973	139,442,092	7,617,942
El Paso	7,159	300,685	10,014	166,632	20,802	460,206	56,428
Eagle Pass	228	9,561	330	14,994	2,687	84,292	14,298
	108,792	4,569,267	151,752	26,243,656	2,681,784	140,254,238	7,711,849

Customs district.	Lubricating and heavy paraffin.		Residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
Laredo	2,819	$900			274,335	$24,723
Galveston	268,076	51,859			330,301	59,539
Sabine	1,496,736	178,586	238,414,421	$7,747,112	409,608,207	18,335,021
El Paso	105,937	23,241			1,033,460	113,485
Eagle Pass	25,914	6,253			134,761	23,568
	1,899,482	263,839	238,414,421	7,747,112	411,381,064	18,556,336

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Petroleum exported from Texas in 1914 and 1915—Continued.

1915.

Customs district.	Crude, including all natural oils.			Naphtha.		Illuminating.	
	Quantity.		Value.	Quantity.	Value.	Quantity.	Value.
	Barrels.	*Gallons.*		*Gallons.*		*Gallons.*	
Laredo	11,114	466,807	$7,821	37,088	$6,534	106,523	$12,067
Galveston	12	520	30	45,447	5,637	90,000	8,550
Sabine	97,268	4,085,242	141,490	26,920,363	3,144,250	114,309,779	6,914,439
El Paso	72,181	3,031,599	98,206	167,032	22,033	690,307	79,188
Eagle Pass	90	3,767	175	17,327	2,739	14,697	2,099
	180,665	7,587,935	247,712	27,187,257	3,181,193	115,220,306	7,016,343

Customs district.	Lubricating and heavy paraffin.		Residuum.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Gallons.		*Gallons.*		*Gallons.*	
Laredo	12,784	$4,004	61,055	$1,401	684,257	$31,827
Galveston	70,513	11,461	50	3	206,530	25,681
Sabine	2,435,260	358,945	427,646,347	13,858,457	575,396,991	24,417,571
El Paso	335,032	84,517	.....	.....	4,232,970	283,944
Eagle Pass	20,814	4,253	4,000	160	60,605	9,426
	2,874,403	463,180	427,711,452	13,860,021	580,581,353	24,768,449

Crude petroleum exported from Pacific ports, including shipments to noncontiguous territories, 1913–1915.

Customs district.	1913		1914		1915	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
From—						
Alaska	.....	.....	.....	.....	1,158	$1,158
Southern California	294,327	$280,713	297,327	$236,622	105,590	60,747
Washington	1,475,823	1,281,185	103,775	88,741	157,721	126,168
Oregon	2	3	4	21	.....	.....
San Francisco	580,164	445,494	1,963,849	1,470,045	1,975,153	1,440,481
	2,350,316	1,957,395	2,364,955	1,795,429	2,239,622	1,628,554
To—						
Alaska	4,727	4,723	415,559	319,512	332,623	268,474
Brazil	.....	.....	36,524	49,500	.....	.....
Canada	1,471,098	1,276,465	83,434	72,646	154,364	109,374
Chile	98,000	73,500	173,119	131,250	30,000	18,250
China	.....	.....	41,667	21,000	.....	.....
Guatemala	.....	.....	.....	.....	.....	.....
Hawaii	772,493	598,980	1,614,633	1,201,445	1,636,652	1,174,234
Mexico	3,827	3,213	18	72	8,422	7,619
Panama	.....	.....	.....	.....	55,393	36,878
Salvador	12	12	.....	.....	21,690	13,500
Other	159	502	1	4	488	225
	2,350,316	1,957,395	2,364,955	1,795,429	2,239,622	1,628,554

The table following exhibits the total marketed production of petroleum from 1906 to 1915, in barrels and in gallons, also the separate derivatives exported and their value, together with their sum and value.

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Petroleum marketed in the United States and petroleum products exported, 1906–1915.

Year.	Marketed production.		Exports.			
	Barrels of 42 gallons.	Gallons.	Mineral, crude (including all natural oils, without regard to gravity).		Mineral, refined or manufactured. Naphtha, benzine, gasoline, etc.	
			Quantity (gallons).	Value.	Quantity (gallons).	Value.
1906	126,493,936	5,312,745,312	148,045,315	$7,731,226	27,544,939	$2,488,401
1907	166,095,335	6,976,004,070	126,306,549	6,333,715	34,625,525	3,676,206
1908	178,527,355	7,498,148,910	149,190,017	6,519,849	43,887,044	4,542,551
1909	183,170,874	7,693,176,708	170,337,773	6,027,588	68,758,675	5,799,994
1910	209,557,248	8,801,404,416	180,111,166	5,404,253	100,695,382	8,407,102
1911	220,449,391	9,258,874,422	201,843,355	6,165,403	137,294,606	11,482,761
1912	222,935,044	9,363,271,848	188,711,420	6,770,484	186,000,094	20,459,378
1913	248,446,230	10,434,741,660	194,469,634	8,448,294	188,043,379	28,091,608
1914	265,762,535	11,162,026,470	124,735,553	4,958,838	209,692,655	25,288,414
1915	281,104,104	11,806,372,368	158,263,069	4,282,827	281,609,081	33,885,047

Year.	Exports—Continued.							
	Mineral, refined or manufactured.				Residuum (tar, pitch, and all other, from which the light bodies have been distilled).		Total exports.	
	Illuminating.		Lubricating (heavy paraffin, etc.).					
	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.
1906	878,274,104	$54,858,312	151,268,522	$18,689,622	64,644,765	$1,971,305	1,269,777,645	$85,738,866
1907	905,924,296	59,635,208	152,028,855	19,210,353	75,774,754	2,527,582	1,294,659,979	91,383,064
1908	1,129,004,833	75,988,256	147,769,024	18,971,436	77,551,683	2,793,363	1,547,402,601	108,815,455
1909	1,046,401,072	67,814,406	161,639,609	20,016,107	121,966,249	4,180,495	1,569,103,378	103,838,590
1910	940,247,039	55,642,368	163,832,544	20,921,103	117,605,802	3,732,196	1,502,491,933	94,107,022
1911	1,112,295,006	61,055,095	183,319,645	23,337,126	133,979,087	3,882,463	1,768,731,699	105,922,848
1912	1,026,138,239	62,084,022	216,393,206	28,297,467	266,236,938	6,599,031	1,883,479,897	124,210,382
1913	1,119,441,243	72,042,107	207,639,092	29,608,549	426,872,373	11,125,851	2,136,465,721	149,316,409
1914	1,010,449,253	64,112,772	191,647,570	26,316,313	703,508,021	19,224,250	2,240,033,652	139,900,587
1915	836,958,665	49,988,597	239,678,725	32,459,641	812,216,209	22,325,557	2,328,725,740	142,941,669

PRICES.

The following tables, compiled from weekly quotations in the Oil, Paint, and Drug Reporter (New York), show the fluctuations in export price of the principal types of illuminating oil and of gasoline entering the foreign trade and, for comparison, the wholesale prices of the same products to domestic jobbers at New York. The quotations on illuminating oil are for 150° F. fire test, water-white kerosene; and on gasoline for the 68° to 72° Baumé grade.

Prices of illuminating oil at New York, 1915.

Export price (cents per gallon).				Jobbing price (cents per gallon).		
Date.	Bulk.	Cases.	Barrels.	Date.	Tank wagon.	Barrels.
Jan. 1	4.50	19.50	8.00	Jan. 1	10.00	12.00
Jan. 27	4.25	10.25	7.75	Feb. 5	9.00	.....
Mar. 31	4.10	10.10	7.60	Nov. 8	10.00	.....
Apr. 1	4.00	10.00	7.50			
May 24	.....	9.75	.....			
Oct. 27	4.25	10.00	7.75			
Nov. 23	4.50	10.25	8.15			
Dec. 7	4.75	10.50	8.40			
Dec. 14	5.00	10.75	8.65			

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Prices of gasoline at New York, 1915.

Export price (cents per gallon).			Jobbing price (cents per gallon).		
Date.	Bulk (100-gallon drums).	Cans and cases (lots of 100).	Date.	Wooden barrels.	Auto naphtha, to garages only (steel barrels).
Jan. 1	19.50	24.00	Jan. 1	22.00–23.00	13.00
Aug. 26	20.50	25.00	Jan. 12		12.00
Sept. 4	21.50	26.00	Apr. 5	21.00–22.00	
Nov. 18	22.50	27.00	July 27		13.00
Dec. 4	23.50	28.00	Aug. 16	22.00–23.00	14.00
Nov. 30	24.50	29.00	Aug. 29	23.00–24.00	15.00
			Sept. 8	24.00–25.00	16.00
			Oct. 8		17.00
			Nov. 3	25.00–26.00	18.00
			Nov. 22	26.00–27.00	19.00
			Dec. 8	28.00–29.00	20.00
			Dec. 20	29.00–30.00	21.00

FOREIGN OIL FIELDS.

NORTH AMERICA.

CANADA.

GENERAL STATEMENT.

The steady decline that has characterized the production of petroleum in Canada since 1907 was reversed in 1915 as a consequence of increased production in the Lambton and Dutton fields in Ontario, sufficient to offset the usual decline in yield of the other contributing fields both in Ontario and in New Brunswick. This increase, which is less than 1 per cent of the output in 1914, was a result of the efficient handling of old wells, some of which have been producing for 40 to 50 years, and the rejuvenation of a few wells of slight production that had been abandoned during the period of low prices in 1914. The Bell River field, in Essex County, Ontario, which was opened in 1913, was practically abandoned in 1915.

DEVELOPMENT.

The following able summary by W. E. Park, of Chatham, Ontario, field representative of the Oil City Derrick, shows the results of drilling activity in Canada in 1915:

On the whole, development work has not been as active in 1915 as in the preceding year, largely owing to the financial conditions. The only new oil production of any moment is that in Sarnia township, where Charles Foster, of Bradford, Pa., drilled about six or eight wells and secured fair returns. Only a few wells have been drilled in the older fields of Lambton, and these have been all small pumpers. Outside these, the drilling of 1915 has been practically all wildcatting.

In British Columbia the B. C. Oilfields (Ltd.) has continued its prospecting on Graham Island without securing commercial returns. This test is not yet finished. Two companies are drilling in the Flathead district of southeastern British Columbia and have reported encouraging shows of oil but not in commercial quantities. The Pitt Meadows test is reported still in progress, but the outlook is not encouraging.

In the province of Alberta probably the most promising test is that commenced in August at Vermilion Chutes, in the Peace River district, by the D. A. Thomas syndicate. This test is still under way.

In the Calgary field a great many tests have been abandoned. The Southern Alberta Oil Co. has secured a producing well at 3,527 feet and is refining the light oil into gasoline, most of which is sold locally. The Alberta Petroleum Consolidated people claim to have a well good for 100 to 150 barrels but have not attempted to produce. The Dingman No. 1 of the Calgary Petroleum Products (Ltd.), which was

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last year a small producer, yielding 387 barrels, is now being deepened. A number of other companies have claimed important shows, but these are the only definite commercial results of two and a half years of drilling.

In the Sweetgrass field of Southern Alberta no oil in commercial quantities has yet been discovered, but a large gas production has been developed, and arrangements are now being made to market this gas.

Ontario wildcatting has been confined largely to drilling for gas to the east of the Lambton and Kent fields. Several tests were made in the vicinity of Delaware, Middlesex County, early in the year, two small gassers and a number of dusters were completed, but the ultimate production was neither large nor certain enough to justify piping. The Volcanic Oil & Gas Co. drilled one test on the Holmes farm near Strathroy, encountering a show of oil but no gas. The Breston Oil & Gas Co., drilling near Hespeler, has nothing commercial to report.

In the older gas fields of the province development work has been rather limited. In the Kent field the Union Natural Gas Co. drilled a few good producing wells. The Glenwood, Beaver, and Canadian interests have also done a limited amount of drilling, the first named completing three good wells in Lake Erie. In the Welland-Haldimand fields further east comparatively little drilling has been done this year.

In the eastern provinces New Brunswick has practically no development work to report, though the recently completed reorganization of the companies controlling the Alberta field paves the way to more extensive development.

As a result largely of war conditions nothing further has been done in connection with the proposed development of the oil-shale deposits in New Brunswick. In the course of the last 25 years spasmodic interest has been shown by capitalists in the oil-shale deposits, and several projects have been mooted for the development of these deposits on the same lines as the oil-shale industry of Scotland. Geologists and shale experts have repeatedly examined the properties, and samples of the shale have several times been shipped to the Scottish retorts, where tests showed the shale to be of good value. Incidentally there have been several changes of possession, but so far no large development work has been attempted.

In the Province of Quebec some drilling has been done in the vicinity of St. Hyacinthe County, and a small gas supply insured. This may be piped to Montreal.

PRODUCTION.

Petroleum produced in Canada, 1906–1915.

[Reported by Canada Geological Survey.]

Year.	Quantity (barrels).[a]	Value.	Average price per barrel.
1906	569,753	$761,760	$1.337
1907	788,872	1,057,088	1.340
1908	527,987	747,102	1.415
1909	420,755	559,604	1.330
1910	315,895	388,550	1.230
1911	291,096	357.073	1.227
1912	243,336	345,050	1.418
1913	228,080	406,439	1.782
1914	[b] 214,805	343,124	1.590
1915	215,464	300,572	1.392

[a] Barrels of 35 imperial gallons. The Canadian barrel of 35 imperial gallons is the practical equivalent of the United States barrel of 42 gallons, the difference being less than 0.03 per cent.
[b] Includes 387 barrels from Alberta.

Petroleum produced in Ontario and New Brunswick, 1911–1915, in barrels.

[Reported by supervisor of petroleum bounties at Petrolia, Ontario.]

District.	1911	1912	1913	1914	1915
Bothwell	35,244	34,486	34,349	33,961	33,395
Dutton	6,732	4,335	4,610	2,190	5,401
Lambton	184,450	150,272	155,747	154,186	161,368
Leamington, Onondaga (Brant County)	13,501	7,115	4,172	2,437	1,490
Tilbury and Romney	48,708	44,727	26,824	18,530	12,742
Belle River	.....	.....	464	1,191	46
Total Ontario	288,635	240,935	226,166	212,495	214.442
New Brunswick	2,461	2,679	2,111	1,725	1,020
Total Canada	291,096	243,614	228,277	214,220	215,462

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PRICES.

Average monthly prices per barrel for crude oil at Petrolia, Ontario, 1911–1915.

Month.	1911	1912	1913	1914	1915	Month.	1911	1912	1913	1914	1915
January	$1.22	$1.26	$1.681	$1.89	$1.305	August	$1.22	$1.44	$1.790	$1.47	$1.305
February	1.22	1.35	1.738	1.89	1.305	September	1.24	1.44	1.790	1.45	1.440
March	1.22	1.38	1.761	1.89	1.305	October	1.24	1.44	1.790	1.41	1.480
April	1.22	1.38	1.780	1.80	1.305	November	1.24	1.48	1.831	1.36	1.605
May	1.22	1.40	1.790	1.00	1.305	December	1.24	1.59	1.856	1.36	1.700
June	1.22	1.42	1.790	1.58	1.305						
July	1.22	1.42	1.790	1.56	1.305	The year	1.22½	1.42	1.782	1.59	1.395

MEXICO.

GENERAL STATEMENT.

The production of nearly 33,000,000 barrels of petroleum in Mexico in 1915 represents a gain of 55 per cent over the output in 1914 and established a new record for production in that country.

The following extracts from an able review of the Mexican industry by George Blardone, field correspondent of the Oil and Gas Journal (issue of January 13, 1916), chronicle the important developments in 1915 and indicate the unfavorable conditions under which the record output was obtained.

The quantity of oil produced in Mexico during the past year must not be confounded with the potential production of the Republic's completed wells. Suffice it that many producing wells are closed in altogether, and that many other wells are pinched down to a minimum. This last is especially true of both the Topila and Panuco fields, although it applies to every pool in the Republic, with the exception of the Isthmus country. Panuco offered the only capital well drilled in during the year. This was No. 1 Los Chotes, drilled as an offset to La Corona's big gusher of 1914 by George Harmon and associates. The well was unique inasmuch as it demonstrated the pronounced dip of the limestone containing pay. The well was less than 100 feet from the Corona well, but the drill was sent 314 feet deeper than the latter before the big pay was encountered. The well flowed into a steel tank which had been erected for the reception of its production, and, under gage, filled the tank at the rate of 60,000 barrels a day. One 10,000-barrel well, one of 3,000 barrels, and a "jitney" (100 barrels), completed the list of pay completions. The two salt-water wells were both drilled below the 2,700-foot level ere the fluid was encountered, the field thus running true to form in this respect.

In the Topila field, the only completion of special note during the year was American Fuel Oil Co.'s No. 1 Loma del Pozo, which, while it might be termed as yet an oil well of practically unknown volume, as a gasser ranks second to none in the Republic. This well was completed at 3,005 feet, after much trouble had been experienced with the hole. The wells "blew in"—the expression is used in its literal sense—unexpectedly, producing a great volume of gas for several days, the gas being finally accompanied by oil. A conservative estimate of the oil production of the test prior to its being shut in was 1,500 barrels. The gas pressure hovers between 800 and 900 pounds and the escaping gas has a tendency to freeze up the gate and frost the derrick. In fact, the well has behaved quite freakishly, a recent instance being the sudden blowing out of bowlders from between the 15-inch and 12-inch casings, the blowout coming suddenly and as quickly subsiding of its own accord. The well, however, proved an extension of the Topila field to the southeast and considerable activity among lease men was the result of its completion.

The Southern fields were practically devoid of interest during the year. The largest completion was a well on the Tepetate (No. 1 Sandoval), not far from Juan Casiano. This well is the property of the Cortez Oil Corporation, and is good for 4,000 barrels. An offset well drilled prior to this one is declared good for 1,000 barrels. Penn-Mex Fuel Co. had one small pay completion in the Alamo tract as the year drew to a close. Mexican Eagle had another small well completed in the Alazan as the year commenced and drew a salt-water well at Los Naranjos (No. 2). Huasteca Petroleum Co. made no attempt to complete any wells in its territory during the year.

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In the miscellaneous column is one small completion with pay, American Fuel Co.'s No. 1, lot No. 7, Lomasy Llanos. This district is between Tampico and Topila on the northerly bank of the Panuco River. At 2,373 feet the drill went into salt water, but this water was plugged off and the test declared good for about 40 barrels from the 2,200-foot level, where oil had been encountered as the drill descended. A feature was the practical absence of gas.

At Chila, which is on the line of the San Luis Potosi Railroad, between Tampico and Ebano, Mexican Gulf Oil Co. abandoned two tests during the year. Despite the exigencies of the war, which marked the spring months of 1915 in the petroleum belt in the Republic, the actual damage to property sustained by oil companies was comparatively small. The most damage inflicted was suffered by the Mexican Petroleum Co. at Ebano, at which place Villistas, in force, came in contact with Constitutionalist forces and heavy fighting resulted. The company lost one 1,000-barrel steel tank, two 5,000-barrel tanks, and one 55,000-barrel tank, while three 55,000-barrel tanks were badly damaged. The oil losses aggregated about 150,000 barrels of oil. Buildings, etc., were more or less damaged by shells aimed at Constitutionalist forces. Eventually the Villistas were driven back. Villistas occupied Panuco and the Panuco fields in May, stopping oil shipments from going down the Panuco River, but no other material damage resulted. The delay in river shipments incident to this occupation was immaterial, for companies exporting Panuco crude had ample oil in storage at Tampico, hence exports were not affected. Pipe-line transportation from the southern fields to seaside, either at Tampico or Tuxpam, was never interfered with.

On March 24 two incidents enlivened the southern fields. On that day the first tanker consigned to the Penn-Mex Fuel Co. at Tuxpam arrived off Tuxpam bar and commenced loading from the Penn-Mex's new seagoing loading lines, thus affording an outlet for the company's production at Alamo. Also, on the same day, the fire which had threatened the existence of the Mexican Eagle's great well at Potrero del Llano was finally extinguished.

During the year Mexican Eagle completed an extension of its narrow-gage Cucillos-Los Naranjos Railway from the latter place to its holdings in the Tepetate where it has derricks up for drilling. This extension, like its parent, is of 24-inch gage, 9½ kilometers in length, and is operated with mule power.

Penn-Mex Fuel Co. introduced steam power on its railway from Zapatol to Alamo during the year.

The tremendous flood on the Panuco River during the last week in September and early October shoaled the bar at the mouth of the river below Tampico to an extent that seriously interfered with shipping, and also shoaled several crossings in the Panuco River below the town of Panuco. As the year closed, the Government dredge is at work removing the shoal at the mouth of the Panuco, and the Panuco Transportation Co.'s dredge is at work deepening the river crossings to permit oil-barge tows from Panuco to load to usual normal depth, i. e., 8 feet.

Tampico-Panuco Valley Railway [Co.] has nearly completed constructing a railway between Tampico and Panuco via Topila and has already received a consignment of rolling stock for the road. No date has been set for the inauguration of the Tampico-Panuco service.

There was no additional pipe-line construction during the past year, and steel storage, approximating 18,000,000 barrels capacity, remains substantially the same, with the prospect of some augmentation of steel storage capacity during the year at hand.

A careful estimate of the stocks on hand in Mexico as 1915 faded into the year at hand found the total equaling 18,431,153 barrels. The bulk of this oil was in steel (or its equivalent) storage, this class of storage equaling 12,230,362 barrels; the earthen storage equaled 6,200,291. Of the earthen storage perhaps fully 25 per cent of it is not marketable as oil. The earthen storage appreciably declined during the year, this being especially true of Panuco, where companies bended their efforts to close in wells where production was not moving, and also in moving earthen storage as best they may to the end that several companies entirely rid themselves of this class of storage. The high water in September-October also accounted for some of the sumps that contained oil. The most important decrees affecting the oil industry gazetted by the Constitutionalist Government during 1916 was the decree of Vera Cruz, of date January 7, 1915, which was received and made effective in both the Tampico and Tuxpam sectors some five or six days later. This decree, in brief, declared that until the compilation of new laws governing the petroleum industry in Mexico was completed and the laws gazetted, all work appertaining to the drilling of wells, etc., must suspend and remain so unless specifically authorized to continue by the central Government. This decree immediately suspended all drilling and petroleum construction

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operations. The decree was interpreted by the Government to in no way interfere with the "exploitation" of wells already completed or with shipments of petroleum from such wells, hence there was no stoppage of shipments either domestic or export nor the closing in of completed wells. This decree was shortly followed by the establishment of technical inspection offices at both Tampico and Tuxpam; and on April 28, 1915, the department of fomento, under which jurisdiction these inspection offices were empowered, authorized these offices to grant provisional permits for drilling operations and construction work having to do with the industry when proper application was made for same by operators. These instructions remain in force even now, and the operations of 1915 were carried out under them.

On August 14 a decree issued forbidding the drilling of any well within 30 meters of the boundary of the property upon which such test was located.

On November 15 oil companies and operators were given until January 15, the present year, to file with the department of fomento in Mexico City (the department's circular No. 11) detailed data, as set forth by the order, reviewing the capitalization of the company, its officers, land holdings, wells owned, etc. The penalty for noncompliance with this order will be nonrecognition by the authorities, and no permits for the exploration or exploitation of petroleum will be issued such delinquents, be they individuals or companies.

In brief, the decrees reviewed above were the major decrees affecting the industry promulgated the past year. The new laws, the compilation of which were alluded to in the decree of Vera Cruz, have not yet been gazetted.

PRODUCTION.

The following figures are compiled from the best information available.

Petroleum produced in Mexico, 1907–1915, in barrels.

1907	1,717,690	1910	3,332,807	1913	25,902,439
1908	3,481,410	1911	14,051,643	1914	21,188,427
1909	2,488,742	1912	16,558,215	1915	32,910,508

IMPORTS.

Petroleum and petroleum products imported into Mexico from the United States, years ending June 30, 1913, 1914, and 1915.

	1913		1914		1915	
	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.
Crude	16,138,930	$590,098	14,900,388	$532,780	5,707,481	$216,656
Naphtha	67,419	8,210	45,446	4,112	81,615	7,702
Gasoline	101,390	18,977	267,744	48,055	475,840	63,521
Illuminating	1,225,289	96,668	971,355	153,108	1,763,624	198,816
Lubricating	889,577	211,729	791,556	186,134	797,894	182,201
Residuum	15,572	706	1,475,242	42,210	594,318	15,030
	18,438,177	925,388	18,451,731	966,399	9,420,772	683,926

Mineral oils imported into Mexico from the United States, years ending June 30, 1906–1915.

Year.	Crude.		Refined, including residuum.		Total.	
	Quantity (gallons).	Value.	Quantity (gallons).	Value.	Quantity (gallons).	Value.
1906	14,366,495	$766,353	3,295,325	$616,479	17,661,820	$1,382,832
1907	19,992,434	1,037,226	3,906,472	511,990	23,898,906	1,549,216
1908	17,523,440	901,115	1,839,803	320,235	19,363,243	1,221,350
1909	27,554,581	1,184,398	1,979,093	306,579	29,533,674	1,490,977
1910	41,202,786	1,428,632	2,333,558	357,258	43,536,344	1,785,890
1911	24,398,337	814,298	2,895,876	349,787	27,294,213	1,164,085
1912	22,752,588	884,320	1,659,566	259,234	24,412,154	1,143,554
1913	16,138,930	590,098	2,299,247	335,290	18,438,177	925,388
1914	14,900,388	532,780	3,551,343	433,619	18,451,731	966,399
1915	5,707,481	216,656	3,713,291	683,926	9,420,772	683,926

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WEST INDIES.

TRINIDAD.

Progress in the petroleum industry of Trinidad in 1915 is described as follows in a report by Consul Andrew J. McConnico at Trinidad.[1]

There have been noteworthy developments in the oil industry of Trinidad, British West Indies, during the past year. Two of the larger companies have made marked advances and now may be said to be established on a firm basis.

The United British West Indies Petroleum Syndicate, at Point Fortin, is ready to supply oil fuel under contract, and several such contracts have been closed. Lately a number of ocean vessels also have called to replenish their supply of oil fuel obtained from this company. Only a few weeks ago a well was sunk which proved to be very valuable, the flow from the gusher being about 6,000 barrels per hour.

The Trinidad Leaseholds (Ltd.), another big company, is at present actively engaged in laying pipe lines for the transportation of its oils from the Morne L'Enter reserve via Fyzabad to Pointe-a-Pierre, near San Fernando, where a pier 300 feet long has already been constructed. The harbor at this point is very suitable for the anchorage of ocean vessels while obtaining supplies of oil fuel.

The Central Oilfields (Ltd.), at Tabaquite, is largely interested in refining petrol and kerosene, the oils at this place being of a paraffin basis. It ships regularly to points in British Guiana and the West Indies, besides supplying a great deal for local consumption.

The fuel oils produced in Trinidad are being used to some extent by the British Admiralty, filling all the necessary requirements, and within the last year the use of the oils locally for fuel purposes has made some advances. A few of the larger sugar factories have installed oil-burning appliances, and the Trinidad Electric Co. (Ltd.), which supplies power and light to the tramway company and electric-lighting company of Port of Spain, is now converting its boilers and plant to use fuel oil instead of coal. The Trinidad Government Railway is making trials of oil in its locomotives. So far the tests have proved quite satisfactory, and it is likely that in the near future the whole system will be operated by fuel oil instead of patent fuel. Some of the smaller government boats and a number of privately owned vessels plying the Gulf of Paris are soon to be equipped with oil-burning machinery. Already some of the smaller power plants of the city have secured such equipment and have found the cost of operation decidedly less than when using coal.

The introduction of oil-burning machinery in this colony is due largely to the efforts of Alexander S. Hay, an American mechanical engineer. The increasing price of coal is also responsible, fuel oil being more economical. Throughout the colony, in fact, coal, except for bunkering purposes, is likely to be entirely superseded by fuel oil; and with Trinidad leading the way it is likely that other British colonies will follow.

The Brighton Oil Co. remains in the forefront in oil production and ships large quantities of crude oil to the United States regularly. Much of the machinery for this and the other companies mentioned is imported from the United States, and all of the oil-burning equipment now being installed is of American manufacture.

Petroleum produced in Trinidad, 1908–1915, in barrels.

1908	169	1911	285,307	1914	643,533
1909	57,143	1912	436,805	1915 (estimated)	750,000
1910	142,857	1913	503,616		

CUBA.

Drilling activity in Cuba in 1915 failed to yield encouraging results. In the vicinity of Cardenas several shallow tests and one deep test (2,400 feet) have been drilled by the Cuban Oil Co. during the last two years, without success so far as oil is concerned. At the end of 1915 the Union Oil Co., of Habana, was reported to have reached a depth of 360 feet in a test well 12 miles east of Habana. A fair showing of amber-colored oil was said to have been obtained in this well at a depth of 320 feet.

[1] Commerce Repts., Jan. 7, 1916.

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CENTRAL AMERICA.

GUATEMALA.

By an executive decree published in El Guatemalteco on December 20, 1915, the Government of Guatemala has reserved the absolute title "to all sources of petroleum and hydrocarbons in general" that exist within the Republic. Provision has been made, however, for the disposition and exploitation of such lands under a leasing system supervised by the minister of public works. Leases, which may not exceed a term of 10 years, can be issued only to native or naturalized citizens of Guatemala.

In the vicinity of Juticalpa, Department of Olancho, an American citizen residing in Honduras is reported to have discovered a bed of asphalt of exceptional purity, which, as indicated by outcroppings, is of considerable areal extent.

COSTA RICA.

Prospects for the immediate exploitation of the petroleum resources of Costa Rica are good, according to a report dated September 23, 1915, by the British minister at Panama, which announces that a contract has been made between the Costa Rican Government and an American concessionaire for the development of the prospective oil fields in the Provinces of Comarca de Limon, Guanacaste, and Comarca de Punta Arenas. Unofficial reports in December were to the effect that the contract for the concession had received the signature of President González and was merely awaiting confirmation by the Costa Rican Congress. The American concessionaire was reported to comprise a group of capitalists headed by Leo J. Greulich, a well-known oil operator in Oklahoma.

The terms of the proposed concession are said to include the exclusive right to carry on oil investigations and operations in the three provinces indicated for a period of five years, with the privilege of denouncing such tracts as may be desired for further development. These tracts are made subject to lease for an uninterrupted period of fifty years, upon the payment of a royalty of 10 per cent of the net proceeds on the oil produced. At the expiration of the leases, the Costa Rican Government reserves the right to purchase the developed properties at their market value, if their renewal does not appear to be more desirable.

The value of this concession lies not only in the favorable terms it provides but in the fact that, should an important oil field be developed, an easily accessible and practically unlimited market is available at the terminals of the Panama Canal, which can be reached by a pipe line less than 300 miles long.

SOUTH AMERICA.

COLOMBIA.

The status of petroleum explorations in Colombia in the later part of 1915 is shown in a report dated November 8, 1915, by Consul Isaac A. Manning,[1] at Barranquilla, which states:

[1] Commerce Repts., Dec. 7, 1915.

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The petroleum deposits of Colombia continue to attract attention from capitalists; and, while the only active exploration work is being done by the Standard Oil Co. in the Sinu region, numerous other syndicates, principally from the United States, have recently sent investigators into this country.

Petroleum seepage, heretofore unrecorded, has been found in all the departments bordering on the Magdalena River as far south as Girardot, where the railway connects the steamboat traffic of the river with Bogota. In the Magdalena Basin some optional contracts have been taken, which, if made operative, will call for the commencement of active boring operations on the lands during the next 18 months. In most of these cases the names of the principals have been reserved.

The Colombian Congress has had under consideration several legislative bills governing petroleum exploration, but so far nothing has been done with any of them. As Congress will probably adjourn on November 18, it is thought unlikely that any important legislation will be adopted regulating this industry.

The visit to Colombia in the spring of 1916 of a party of petroleum capitalists from the United States is believed to indicate that more active exploration of Colombia's petroleum resources will be undertaken in the near future.

VENEZUELA.

Although no commercial production of petroleum is credited to Venezuela in 1915, developments during that year indicate that it will take its place among the oil-producing countries of the world in the near future. This is practically assured by the acquisition of control of the Venezuela Oil Concessions (Ltd.), having a concession covering approximately 3,000 square miles in the districts of Maracaibo and Bolivar, State of Zulia, by the Royal Dutch-Shell group, and the commencement of active work by the latter syndicate on the erection of a modern refinery on Curacao, one of the Leeward Islands, off the north coast of Venezuela. Four wells, all of which contain oil and gas, are reported to have been drilled by the Venezuela Oil Concessions (Ltd.).

The Caribbean Petroleum Co., an American corporation operating in the Sucre district on the eastern side of Lake Maracaibo, continued prospecting in the Mene Grande field, on Matatan River, with success. A 6-inch pipe line 15 miles long was constructed from the field to San Lorenzo on the lake, and storage tanks were erected at the terminals of the line. The wells in this field, of which there are six, credited with a capacity of 300 to 400 barrels a day, were capped pending the development of transportation facilities. In the Perija field, 50 miles west of Lake Maracaibo, an initial test was completed at a depth of 1,227 feet, at which point oil was struck in considerable quantities and shut in.

Other companies were organized to prospect concessions in the Lake Maracaibo region during 1915.

GUIANA.

The following quotation from a report by Consul George E. Chamberlain,[1] at Georgetown, British Guiana, indicates the interest that is being taken in possibilities of petroleum occurrence in that country:

In the last annual report of the Institute of Mines and Forests of British Guiana a paragraph states:

"Persistent rumors of the finding of oil in the northwest district are current, and there is some reason for placing credence in them. The truth or otherwise will soon

[1] Commerce Repts., Feb. 23, 1916.

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be finally disposed of one way or the other, as the Government intends very shortly to bore an artesian well in the district from which the indications of oil are reported. This will show the character of the formation of the country to some depth and reveal to the geologist whether conditions are favorable as a source of an oil supply."

The artesian well proposed by the Government has not yet been bored, but private interests have recently imported a well-drilling plant from Trinidad, fitted with 6, 8, and 10 inch bores. The plant is in the charge of an expert, who has left Georgetown for the district where it is proposed to bore the first well. In the Daily Argosy appears the following discussion of the subject:

"No private enterprise has ever before sent a proper drilling plant to the district, and it must be remembered that, owing to the restrictive nature of the regulations, this is not an adventure to be embarked upon lightly. Prospecting for oil in this colony is not merely a case of risking a certain amount of money in sending up a drilling apparatus to the district in which the prospector hopes to find oil. The whole business has to be carried out under very stringent rules.

"The financial obligation incurred by any prospector who takes up the work seriously is considerable, apart from the actual cost upon the expedition itself, which is bound to be heavy, and this is undoubtedly the reason which has hitherto deterred private enterprise from engaging in any practical exploration. It is sincerely to be hoped that the venture which is now being embarked upon will prove successful, and even if it is not its promoters will merit commendation for having had the courage of their convictions in making the attempt.

"After an extended investigation of the Waini River district in the autumn of last year Mr. E. C. Buck, director of public works, reported that the oil indications were most favorable. Proof of the accuracy of this view would be an immense benefit to the colony as well as to those concerned in the successful investigation, who would certainly deserve all the profit accruing to them as a result."

BOLIVIA.

Progress toward the testing of promising oil areas in Bolivia is indicated in a recent report that a syndicate designated the "Sindicato Petrolífero del Oriente Boliviano" has been formed by Chilean capitalists to exploit an area of 545,000 hectares (1,345,150 acres) in eastern Bolivia. To carry on the work of exploitation subscriptions for approximately $10,000,000 are to be raised, chiefly from the nitrate producers of northern Chile who are desirous of procuring an adequate and economical supply of fuel.

On one concession, in the Federal Perez district, near the head of Ariha Valley, granted by the Bolivian Government to a Hungarian who has had experience in the oil fields of central Europe, a test well was reported to have been actually started before the close of 1915.

ECUADOR.

The following information from a report[1] dated June 5, 1916, by Consul General Frederic W. Goding, at Guayaquil, Ecuador, shows the present status of the petroleum industry in that country:

The development of the petroleum deposits of Peru has directed attention to those at other points on the west coast of South America, and the Ecuadorean oil fields have been studied in recent years by promoters and engineers. Bituminous seams bearing small quantities of petroleum occur in various places in the northern Provinces of Ecuador, where several claims have been located. The seepage there has been utilized by the Indians for cooking their food. Petroleum is said to exist in marketable quantities in the Province of El Oro near Santa Rosa, not far from the oil fields of Peru. The district comprises an extensive portion of the flat lands of the Province, which is intersected by a number of streams navigable for vessels of considerable draft, with an abundance of growing timber in the neighboring mountains available for construction purposes.

The known deposits where outflows are frequently found occur in the desert peninsula, near the port of Santa Elena, extending from Puntilla, the most western point

[1] On file in Department of State.

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of Ecuador, eastward at least to the town of San Vicente. This oil field is 90 miles southwest from Guayaquil and 740 miles from Panama. There are telephone and telegraph services and a good automobile road between the former city and the oil field. The surface of the country is nearly level, with minor undulations, and slightly inclined toward the sea.

In this district the layer containing the petroleum, known by its black color, is blue shale of unknown thickness, superficial at some points, and elsewhere covered with marine débris, is very spongy, and rests on a base of impermeable sandstone, which prevents much filtration, although it is impregnated with oil. It is nearly horizontal, of variable thickness, about 3 feet at the center, and covers an area extending 6 miles north and south and about 20 miles inland. The presence of a small oil fountain, together with considerable gas, would indicate that deep drilling would produce flowing wells. The present method of collecting the oil is to excavate holes 10 by 10 feet square from 10 to 50 feet down to the impermeable sandstone; by seepage there is an annual yield of about 25,000 barrels. The output is limited to local demand. The wells produce from three months to three years.

In 1910 a well had been sunk to about 150 feet and another in 1913 to a similar depth, passing through several small veins of oil and strong gas, while a third, of 1,250 feet, was nearly ready to begin operations, work with them being discontinued on account of lack of funds. Judging from the depth at which oil is found in the adjacent Lobitos field of Peru, it is believed that oil in commercial quantities will be reached here at about 1,000 feet. The deposits are similar to those at Lobitos and Negritos, which have yielded about 70,000 tons annually for some years. The latter has been a steady producer for more than 30 years.

Drilling, including casing, costs about $7.50 per foot to a depth of 1,500 feet, and about $10 per foot to 2,500 feet. There is an abundance of native labor, costing 50 to 75 cents per day; the drillers and mechanics must be brought from the exterior, with wages from $100 to $150 a month.

The petroleum produced in Ecuador near the surface has lost some of its volatile constituents as a result of the method of collecting it. An attempt was made at Santa Elena to refine it but was later abandoned. A small plant situated at the beach near there treats limited quantities for the asphalt only, no effort being made to save the lighter oils. An analysis made in London gave the specific gravity at 60° F., being 0.8798.

Recently a law was promulgated here exempting from all fiscal and municipal duties and taxes the production and exportation of petroleum and its derivatives for a period of 20 years. Some mineral tar is exported each year.

PERU.

GENERAL STATEMENT.

As a consequence largely of betterments introduced by the International Petroleum Co. (Ltd.) in refining and in marketing facilities after its acquisition of the controlling interest in the London & Pacific Petroleum Co. (Ltd.), the Lagunitos Oil Co. (Ltd.), and the West Coast Oil Fuel Co. (Ltd.) in 1914, the output of petroleum in Peru attained a record total in 1915.

The bulk of the production came as usual from the Negritos district, 6 miles south of Talara, where new wells were completed in 1915. At Talara the International Petroleum Co. (Ltd.) has a refinery, with a capacity of 2,500 barrels of oil a day, which manufactures gasoline and other petroleum products to supply the local and adjacent coastwise markets and loading piers from which crude oil is shipped in tank steamers to the company's refinery at Ioco, near Vancouver, Canada.

In the Lagunitos field, which lies about 12 miles south of Talara and is connected with it by a pipe line and a narrow-gage railroad, a number of new wells were drilled in 1915, as a result of which the output was materially increased.

Twelve miles inland from these coastal fields tests were started on the La Paz tract of 2,560 acres acquired in 1913 by the Lagunitos Oil

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Co. (Ltd.), to which property a branch railroad was constructed from Talaro Tablazo.

In the Lobitos district, 10 miles north of Talara, which is controlled by the Lobitos Oilfields (Ltd.), production was also increased notably in 1915. Production in this field is derived from two sands, the upper found between 1,100 and 1,400 feet and the lower between 2,000 and 2,500 feet.

One deep well has proved the presence of still lower sands, but these sources are still undeveloped.

There is no refinery at Lobitos, the production being loaded on the company's tankers by means of an 8-inch sea-loading line and shipped to California for refining.

During 1915 efforts by the Lobitos Oilfields (Ltd.) to develop an oil field on its property at Punta Restin, 13 miles north of the Lobitos field, proved disappointing.

In the Zorritos district, 80 miles north of Lobitos, development work was continued, but a moderate decline in petroleum output was recorded.

Important legislation affecting the petroleum industry in Peru, enacted in 1915, provides for an export tax on petroleum and its products that amounts to approximately 3½ cents per barrel.

PRODUCTION.

Petroleum produced in Peru, 1906–1915, in barrels of 42 gallons each.

Year.	Lobitos.	Negritos.	Zorritos.	Lake Titicaca (Huancane).	Lagunitos.	Total.	
						Barrels.	Metric tons.[a]
1906	[b] 162,000	330,510	42,419	1,365	.....	536,294	71,505
1907	[b] 279,000	396,750	65,476	15,000	.....	756,226	100,830
1908	319,898	543,750	71,429	[b] 76,103	.....	1,011,180	134,824
1909	429,195	740,070	70,750	[b] 76,103	.....	1,316,118	175,482
1910	400,080	773,025	107,000	[b] 50,000	.....	1,330,105	177,347
1911	391,290	882,698	64,286	[b] 30,000	.....	1,368,274	182,436
1912	587,048	1,071,000	78,095	[b] 15,000	.....	1,751,143	233,486
1913	557,355	1,136,490	83,343	[b] 10,000	346,073	2,133,261	284,434
1914	504,743	1,032,210	88,136	[b] 10,000	282,713	1,917,802	255,707
1915	664,972	1,355,925	72,736	[b] 1,000	392,618	2,487,251	331,633

[a] One metric ton=7.5 barrels. [b] Estimated.

Petroleum produced, shipped, and in stock and number of producing wells in Lobitos oil field, Peru, 1906–1915.

Year.	Production.		Shipments.	Stock Dec. 31.	Producing wells Jan. 1.
	Metric tons.	Barrels.	Metric tons.	Metric tons.	
1906	[a] 21,600	162,000	17,576	.....	.....
1907	[a] 37,200	279,000	25,821	4,816	.....
1908	42,653	319,898	36,131	8,860	26
1909	57,226	429,195	54,289	11,797	62
1910	53,344	400,080	.....	.....	.....
1911	52,172	391,290	.....	.....	93
1912	78,273	587,048	.....	.....	105
1913	74,314	557,355	.....	.....	110
1914	67,299	504,743	.....	.....	.....
1915	88,663	664,972	.....	.....	.....

[a] Estimated.

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Petroleum produced in Negritos oil field, Peru, 1906–1915.

Year.	Metric tons.	Barrels.	Year.	Metric tons.	Barrels.
1906	44,068	330,510	1911	117,693	882,698
1907	52,900	396,750	1912	142,800	1,071,000
1908	72,500	543,750	1913	151,532	1,136,490
1909	98,676	740,070	1914	137,628	1,032,210
1910	103,070	773,025	1915	180,790	1,355,925

Petroleum produced in Zorritos oil field, Peru, 1906–1915, in gallons.

Year.	Crude.	Refined.[a]	Gasoline.	Benzine.	Year.	Crude.	Refined.[a]	Gasoline.	Benzine.
1906	1,781,600	350,000	54,000	10,000	1911	2,700,000	650,000	.....	200,000
1907	2,750,000	420,000	101,000	20,000	1912	3,280,000	476,620	226,440	.....
1908	3,000,000	500,000	150,000	30,000	1913	3,500,424	565,320	324,000	.....
1909	2,971,510	469,610	96,520	.....	1914	3,701,718	482,850	277,440	.....
1910	4,494,000	.....	.....	.....	1915	3,054,900	461,510	362,230	.....

[a] Kerosene.

CHILE.

In a report [1] dated January 25, 1915, Commercial Attaché Verne L. Havens says, concerning the petroleum prospects in Chile:

It is reported that the country surrounding Punta Arenas, in Chile, contains petroleum and asphalt, and that the deposits lie in a belt which, if extended across the undeveloped territory, would intersect the Comodoro Rivadavia oil fields, in Argentina. The asphalt has been found in small quantities throughout this territory for many years, and even in the crude state burns with a continuous yellow flame. Practically all the ground has been denounced, but the holding company will dispose of 60 to 80 per cent of its interests to an exploration company who will guarantee to exploit if oil is found, or it will give an option for complete sale for cash at the end of 6 months' exploration, or for an additional amount will extend the option to 18 months. If no oil is found, the explorer loses only the cost of his explorations.

It is also reported that there are important oil shales available for development in Chile about 620 miles south of Santiago, with a railway near by; that analyses indicate that the shales contain from 25 to 62 gallons of crude oil per ton; and that 31,100 acres have been denounced as oil claims by persons who are unable to develop but who will transfer their rights to a developing company for 10 per cent stock interest or will give an option for a cash sale.

Late information is to the effect that a new corporation, known as the Union Petroleum Co., has taken over certain concessions granted by the Chilean Government to develop the prospective oil field in the Province of Punta Arenas, northwest of Tierra del Fuego.

URUGUAY.

No definite efforts have been made to develop the petroleum resources of Uruguay, though the use of petroleum fuel has notably increased in that country within the last year.

Marstrander [1] discusses the petroleum possibilities of Uruguay, in part, as follows:

Indications of oil are said to exist on the surface near the city of Melo, Department of Cerro Largo. The oil-bearing or bituminous schists of southern Brazil extend into

[1] Commerce Repts., issue of Mar. 27, 1915.

[1] Marstrander, Rolf, Preliminary report on the mineral resources of Uruguay: Uruguay Ministry of Industries, Inst. Geology and Mines Bull. 2, pp. 43–44, Montevideo, December, 1915.

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this region, and although they have not yet proved profitable, the presence of this formation must be considered important. Recently a boring has been made in the city of Melo which has reached a depth of nearly 500 meters, piercing sedimentary strata of shales and sandstones. At 210 and at 247 meters flows of water were encountered having such a strong odor and taste of petroleum that it could not be used as drinking water.

The institute has planned a reconnaissance of this region with a view to ascertain the oil and coal possibilities by borings, and also the extent and quality of some very bituminous shales containing a rather high percentage of hydrocarbons and nearly 4 per cent of sulphur. Distillations of these shales, taken from the place called Canada de los Burros, made by the Instituto de química industrial, of Montevideo, showed results equivalent to 60,000 liters of gas, 50 kilograms of oil (specific gravity at 28°, 0.910), and 100 kilograms of ammoniacal liquor per ton of schist.

The gas contained a large amount of sulphur, and tests showed a calorific value of 6,000 calories per cubic meter. Further and more important tests are now being carried out by the Instituto de química industrial.

Analyses made in the laboratory of this institute agree with those obtained by the Instituto de química industrial and gave the following results:

	Per cent.
Fixed carbon	6.6
Mineral oil (specific gravity at 28° C., 0.912)	8.7
Gases	2.5
Sulphur	3.9
Water	7.3

These shales show marked analogies to the well-known Scottish oil shales, which are of great economic importance in that country.

ARGENTINA.

The output of petroleum from the Comodoro Rivadavia field, Argentina, in 1915, which was greater than in any previous year, reflects the increase in drilling activity that took place on the Government reserve during that year. In a report dated February, 1916, an abstract of which has been made available to the Geological Survey through the courtesy of Mr. Domingo Nogues. Alberto Schneidewind, president of the Comodoro Rivadavia Petroleum Commission, states that 25 wells have been completed on this tract and that 12 additional wells, now drilling, are expected to be finished before the close of 1916. Of the completed wells, 21 are reporetd to be capable of yielding oil. Of the remaining wells, 1 has been converted into a water well, 1 is utilized as a source of gas for additional drilling, 1 is capped as a gasser, and 1 has been abandoned because of inability to remove lost tools. Developments in this reserve have yet to record their first dry hole, because, as pointed out in President Schneidewind's report, the wells not classed as producers of petroleum are either serving an important purpose or have demonstrated a capacity for oil production, though lost by unavoidable accident.

The depth of the wells ranges from 1,725 to 1,855 feet, with the exception of No. 10, which is being made a deep test, and in February, 1916, was drilling at 2,500 feet. The aggregate capacity of the 21 productive wells is said to average 1,050 barrels a day.

The crude oil ranges in specific gravity from 0.940 to 0.922 (18.9° to 21.8° on the Baumé scale) and on distillation yields from 1.5 to 3.5 per cent of naphtha and gasoline, 15 to 19 per cent of illuminating oils, and 77 to 85 per cent of lubricants, fuel, and coke.

From the field the petroleum is transported by two pipe lines to a topping plant on the ocean front, and eventually to storage tanks

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which are connected with loading racks on a long wharf, recently constructed by the petroleum commission. and with a deep-sea loading line. Storage capacity aggregates 24,000 cubic meters at the shipping point and in the field in the form of covered reservoirs 26,000 cubic meters additional. At Buenos Aires the commission has erected two steel storage tanks with a combined capacity of 12,000 cubic meters. Petroleum is transported between Comodoro Rivadavia and Buenos Aires by two steamers—the *Ministro Ezcurra*, belonging to the navy, and the *Waneta*, under charter by the general board. It is estimated that by means of these two steamers 60,000 barrels of petroleum can be transported a month.

The actual cost of producing petroleum in the Comodoro Rivadavia field is estimated by the commission at about 16 cents a barrel. Freight to Buenos Aires is about 18 cents a barrel.

That the fuel stringency in Argentina brought about by the cessation of coal imports from England at the beginning of the European war can and should be relieved by oil fuel from the Government reserve is the conclusion reached by President Schneidewind. To this end he advocates enlarging the scope of operations on the reserve and the enactment of legislation providing for concessions to private interests covering known petroliferous areas adjacent to the reserve. This solution has the advantage of opening the petroleum fields of this district to development by both Federal and private enterprise, thus eliminating the danger of monopoly, which development by private enterprise alone would involve. By this method the Government would be assured an adequate supply of petroleum for its own needs at cost and any excess could be sold in the open market at the prices received by private producers, which generally involve a fair profit.

The commission itself is disposed to aid private enterprise by selling fuel for drilling at reduced prices and by facilitating in any practicable manner transportation, storage, and shipment of the oil produced.

Petroleum produced in Argentina, 1907–1915.

Year.	Metric tons.	United States barrels.	Year.	Metric tons.	United States barrels.
1907	13	101	1912	6,850	47,007
1908	1,680	11,472	1913	19,050	130,618
1909	2,700	18,431	1914	40,530	275,500
1910	3,050	20,753	1915	75,900	516,120
1911	1,920	13,119			

EURASIA.

RUSSIA.

The statistics of the production of petroleum in Russia in 1915 show an increase of 2 per cent over the output in 1914, but fail to indicate the unfavorable conditions under which this output was obtained. When it is considered that foreign exports of refined products were essentially nil, that drilling supplies were exceedingly costly and difficult to obtain, and that labor was scarce and expensive, the magnitude of the output of petroleum in Russia in 1915 is re-

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markable. The principal factor tending to offset these difficulties was the increasing demand for liquid fuel in Russia, owing mainly to a shortage of coal and wood, that could be supplied only by refinery residuum or by low-grade crude petroleum.

Prices of crude oil averaged high during the year. Owing to strikes in 1914, the price of Baku oil, the standard of the Russian market, was about 43 kopecks per pood, equivalent to about $1.84 a barrel at the normal rate of exchange at the beginning of the European war. Prices fell, however, toward the end of 1914, and 1915 opened with prices equivalent to $1.25 a barrel. Prices then commenced to advance and continued rising until in March, 1915, the equivalent of $1.80 a barrel was reached. With the opening of navigation the increased demand was reflected in prices which advanced to $2.32 a barrel, receding again in the fall to approximately $1.89. In the early part of December the question of Government control and fixation of prices for crude oil at $1.72 a barrel was considerably agitated, after which market quotations advanced rapidly until toward the close of December nearly $2.57 a barrel was reached.

On the Apsheron Peninsula the principal oil fields in the vicinity of Baku had a moderate increase over the production in 1914. The high cost of drilling supplies and of labor tended to restrict field activity to the deepening of old wells rather than to the drilling of new. There were no developments of consequence during the year.

At Grosny, on the north flank of the Caucasus, production declined in 1915, owing to a decrease in drilling operations resulting in part from the cost of materials and in part from a restrictions of shipping facilities due to the employment of the tributary railroad in military transport.

The event of the year at Maikop, west of Grosny, was the completion of a phenomenal gusher on plot 457 in the Neftianaya district, which flowed steadily from March 23 to the close of the year. This well, which was drilled by the Maikop Combine (Ltd.), a subsidiary of the Anglo-Maikop Corporation (Ltd.) and was credited with an initial capacity of 60,000 barrels a day, established a record for the Maikop field as to both production and period of flow. The depth is 1,318 feet.

In the relatively new Ural-Emba district in Uralsk Province, north of the Caspian Sea, drilling activity was slight in 1915 owing to the abnormal conditions caused by the war, and production declined slightly below that in 1914.

The following interesting notes concerning this new and little known area are abstracted from a paper [1] by F. A. Holiday read to the Institution of Petroleum Technologists in London on December 21, 1915:

> For some time past travelers and explorers have reported exudations of oil and gas, occurrences of asphalt, and other surface indications of petroleum at various points in the tract known as the Kirghiz Steppes * * *.
>
> Roughly speaking, the reported signs of petroleum lie between the fifty-first and the forty-sixth parallels of north latitude, and the forty-ninth and fifty-eighth meridians of east longitude. It will be seen that they are distributed over a very large part of the Uralsk Province. To get some sort of an idea of the extent of country involved, we may take a line from the point where the west boundary of the Province reaches the Caspian shore, following this boundary northward to the town of Alexandrovsk Gai, which lies just outside Uralsk, thence east to a point near the town

[1] The Uralsk Province and its oil fields: Petroleum Rev., vol. 33, No. 701; vol. 34, Nos. 702, 703, and 704.

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of Temir, again south to Murtuk, and finally in a southwesterly direction, following more or less the course of the Emba River to the sea again, the southern boundary being, of course, the coast. The area of this figure is, roughly speaking, some 60,000 square miles * * *.

The Uralsk Province has a total area of about 125,000 square miles (284,400 square versts), and is about 3 per cent larger than the British Isles. It is divided into two parts by the Ural River. All the land on the western side of the river, together with a narrow strip on the eastern side, is the territory of the Ural Cossacks; it amounts to some 27,250 square miles and is nearly as big as Scotland. The land on the east belongs to the Crown. * * *

Gurieff, at the mouth of the Ural River, with 11,000 inhabitants, is the chief town after Uralsk. It has up to now served as the headquarters of the various companies operating in the oil fields. * * *

Dos Sor, at which there was no settlement a few years ago, now ranks as one of the towns of the Province; there is of course no post road there, but the oil companies provide a few water stations between Dos Sor and Gurieff, for their own traffic. * * *

In 1899 exclusive rights to search for oil in six volosts (or districts) were granted to Lehmann and the heirs of Doppelmayer. These privileges were renewed several times until near the end of 1909. * * *

At Dos Sor a number of wells were sunk by Messrs. Lehmann and Stahkeev, and some oil was obtained at moderate depths, but in the light of later work it is evident that none of these wells were deep enough to test the locality thoroughly. * * *

At Karaton oil was encountered at various depths, a number of small shows being found at from 30 feet to 60 feet, as well as at lower horizons. At Karatchungul several wells worthy of remark were drilled. In one, in particular, oil was struck at 143 feet and spouted, somewhat intermittently, 90,000 poods in three days and continued to flow at intervals for some time, giving, it is stated, some 300,000 poods. * * *

From the end of 1909 the concession was renewed until November 12, 1912. An English company, the Ural-Caspian Oil Corporation, was formed, and took over all the privileges of the concession, to which two more volosts had been added. * * *

Other companies subsequently acquiring territory within the area of the original concession were the Emba, Messrs. Nobel, the Emba-Caspian, the Kolchida of Baku, and others.

Up till now Dos Sor has been the main center of development. It was brought into prominence by well No. 3, of the Ural-Caspian Co., which on May 13, 1911, from a depth of 732 feet, spouted with great violence; after one and a half days it caught fire and destroyed the derrick but was finally arrested. It began to flow again in February, 1912, was closed down, and reopened in October, 1912, when in the first 24 hours it gave 120,000 poods (1,944 tons) and then settled down to 50,000 poods. Oil from it was received into an ambar, or earth reservoir, but this broke down through flooding after heavy rain and about 300,000 poods were lost. The well was then shut down till proper storage was built. This famous gusher is estimated to have produced in the early part of its history from 1,500,000 to 2,000,000 poods. It has since produced nearly 7,000,000 poods. Last July it was stopped for cleaning and redrilling.

Since the Ural-Caspian No. 3 came in several other fountains have been struck at Dos Sor by the same company, also by the Emba-Nobel, and more recently by the Emba-Caspian Co., and the production from this center has steadily increased. It is still the only field from which oil has actually been exported. There are now some 59 wells yielding oil: Ural-Caspian Co. 32, Emba-Nobel 21, Emba-Caspian 6. * * *

At Makat and Iskene a little drilling has been done since the concession was taken over in 1910 but without any important results. However, it was announced early this year that the Emba-Nobel Co. has a fountain at Makat. Preliminary work or trial drilling has been carried out also at Bli-ule, Bek-Beke, Iman Kara, Satep Aldi, and at other spots.

Drilling by the Canadian-Galician system was employed in the first place by the Ural-Caspian Co., but gradually modifications have been introduced by their engineers to suit the special requirements of the district. The Russian percussion system is also used by other firms. On account of the scarcity of water, oil engines are largely employed. * * *

At Novo-Bogatinsk, on the Cossack lands, 38 miles west of Gurieff, exploration by deep drilling has been started lately by Messrs. Nobel, and by the West Ural Co. * * *

In 1914 the West Ural Co. drilled two deep wells by the rotary system. Finally, in August 6 of this year [1915], Messrs. Nobel struck a gusher stated to have given an estimated yield of 300,000 poods in 24 hours. * * *

There are two 6-inch pipe lines taking oil from Dos Sor via Iskene, a distance of 45 miles, to Rakusha, the shipping port, where the refineries are situated. On account of the shallowness of the water, pipe lines are laid on the sea bed, and terminate at

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platforms 6 miles out, where the barges can moor. Of the two lines from Dossor, one belongs to the Ural-Caspian Co. and is underground and embedded in cement, the other belongs to Messrs. Nobel, and is exposed. The first-mentioned line was at first provided with one pump and could only handle 30,000 poods per diem. The addition of a second pump increased its capacity to 52,000 poods. * * *

At Rakusha refineries have been erected by the Ural-Caspian Oil Co. and the Emba Co. The refining of oil in the district was undertaken in the first place with a view to getting the rebate of 50 per cent of the excise duty on refined products, granted as one of the privileges of the concession.

The production of petroleum in the Ferghana Valley, Turkestan, east of the Caspian Sea, is restricted to the Tchimion and Sel Rokh fields, where the product is absorbed in local markets.

In 1915 the Santo Co. operating in this district installed a refinery at Akkulmiak. The capacity is 10,000 poods (about 1,200 barrels) of oil a day, and the plant is unique in that it is constructed according to a system based on a complete regeneration of heat.

Petroleum produced in Russia, 1906–1915.

Year.	Baku.		Grosny.		Maikop.	
	Poods.[a]	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.
1906	447,520,000	53,723,889	38,373,603	4,606,675	.....	.....
1907	476,002,000	57,143,097	39,214,612	4,707,637	.....	.....
1909	465,954,221	55,936,880	52,058,895	6,249,567	.....	.....
1909	492,500,000	59,123,650	57,033,015	6,846,700	.....	.....
1910	508,456,121	61,039,149	74,048,358	8,889,359	1,304,800	156,640
1911	454,206,853	54,526,633	75,189,591	9,026,361	7,933,936	952,453
1912	473,200,000	56,806,723	65,400,000	7,851,140	9,200,000	1,104,442
1913	404,538,000	48,563,985	73,659,265	8,842,049	4,802,926	576,582
1914	412,246,851	49,489,418	98,445,187	11,818,150	3,956,906	475,019
1915	431,139,305	51,757,419	88,159,052	10,583,320	7,582,000	910,204

Year.	Emba.		Other.		Total.	
	Poods.	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.	Poods.	Barrels of 42 gallons.
1906	.....	.....	[b] 4,721,000	566,747	490,614,608	58,897,311
1907	.....	.....	.....	.....	515,216,612	61,850,734
1908	.....	.....	.....	.....	518,013,116	62,186,447
1909	.....	.....	.....	.....	549,533,015	65,970,350
1910	.....	.....	[c] 2,094,381	251,426	585,903,660	70,336,574
1911	.....	.....	[d] 13,979,771	1,678,244	551,310,151	66,183,691
1912	.....	.....	[e] 18,800,000	2,256,903	566,600,000	68,019,208
1913	7,182,000	862,184	[f] 33,228,000	3,988,956	523,410,191	62,834,356
1914	16,675,000	2,001,801	26,957,000	3,236,134	558,280,944	67,020,522
1915	16,632,000	1,996,639	27,493,000	3,300,480	571,005,357	68,548,062

[a] 61.05 poods=1 metric ton crude; 8.33 poods crude=1 United States barrel of 42 gallons; 8 poods illuminating oil=1 United States barrel of 42 gallons; 8.18 poods lubricating oil=1 United States barrel of 42 gallons; 9 poods residuum=1 United States barrel of 42 gallons; 7.50 poods naphtha=1 United States barrel of 42 gallons; 8.3775 poods other products=1 United States barrel of 42 gallons, estimated; 1 pood=36.112 pounds; 1 kopeck=0.515 cents.

[b] Produced in Berekei and Tchimion oil fields.

[c] Includes as follows: Sviatoi, 1,392,306 poods; Ferghana, 610,500 poods; and Taman, 91,575 poods.

[d] Includes as follows: Sviatoi, 2,515,363 poods; Tcheleken, 10,205,740 poods; and Ferghana, 610,500 poods; other districts, 648,158 poods.

[e] Includes as follows: Sviatoi, 3,300,000 poods; Tcheleken, 13,300,000 poods; and Ferghana, 2,200,000 poods.

[f] Includes as follows: Sviatoi, 4,733,000 poods; Balakhani, 13,860,000 poods; Berekei, 6,000,000 poods; Ferghana, 1,406,000 poods; and Tcheleken, 7,229,000 poods.

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Petroleum produced from pumping and flowing wells in Russia in 1914 and 1915.

District.	1914				1915			
	Pumping (barrels).	Flowing (barrels).	Total.		Pumping (barrels).	Flowing (barrels).	Total.	
			Barrels.	Poods.			Barrels.	Poods.
Apsheron Peninsula or Baku:								
Balakhani	8,049,290	.....	8,049,290	67,050,583	8,010,928	6,003	8,016,931	66,781,039
Sabunchi	17,225,876	.....	17,225,876	143,491,543	17,192,964	.....	17,192,964	143,217,390
Romani	6,148,214	494,143	6,642,357	55,330,834	6,405,817	.....	6,405,817	53,360,458
Bibi-Eibat	7,872,254	789,819	8,662,073	72,155,071	8,200,374	1,299,175	9,499,549	79,131,239
Binagadi	2,142,137	540,216	2,682,353	22,344,000	2,529,532	660,264	3,189,796	26,571,000
Surakany	4,139,114	2,088,355	6,227,469	51,874,820	4,970,730	2,313,565	7,284,295	60,678,179
Caught at canals at Baku	.....	.....	.....	.....	168,067	.....	168,067	1,400,000
	45,576,885	3,912,533	49,489,418	412,246,851	47,478,412	4,279,007	51,757,419	431,139,305
Grozny	10,296,933	1,521,217	11,818,150	98,445,187	10,369,507	213,813	10,583,320	88,159,052
Maikop	a 200,000	a 275,019	475,019	3,956,906	324,850	585,354	910,204	7,582,000
Emba	1,041,417	960,384	2,001,801	16,675,000	1,996,639	.....	1,996,639	16,632,000
Svaitol	642,257	63,985	706,242	5,883,000	778,751	49,460	828,211	6,899,000
Ferghana	214,766	.....	214,766	1,789,000	217,527	.....	217,527	1,812,000
Tcheleken	596,559	2,761	601,320	5,009,000	479,352	.....	479,352	3,993,000
Balakany (hand wells)	870,708	.....	870,708	7,253,000	921,969	.....	921,969	7,680,000
Schukany (hand wells)	838,896	.....	838,896	6,988,000	850,060	.....	850,060	7,081,000
Bereke	.....	4,202	4,202	35,000	.....	3,361	3,361	28,000
Grand total	60,280,421	6,740,101	67,020,522	558,280,944	63,417,067	5,130,995	68,548,062	571,005,357

a Estimated.

Crude petroleum produced on the Apsheron Peninsula and petroleum products shipped from Baku, Russia, 1906–1915, in barrels.

Year.	Production.	Shipments from Baku.					
		Illuminating.	Lubricating.	Other products.	Residuum.	Crude oil.	Total.
1906	53,723,389	8,941,125	1,847,799	179,289	22,697,067	4,001,441	37,667,321
1907	57,143,097	11,450,019	1,724,664	565,689	27,833,892	4,290,500	45,864,764
1908	55,936,880	10,682,750	1,754,034	105,163	23,989,778	5,398,200	41,929,925
1909	59,123,650	8,261,368	1,728,833	1,087,115	23,404,954	6,182,973	40,665,243
1910	61,039,149	9,978,406	1,892,046	1,381,921	24,414,210	6,207,278	43,873,861
1911	54,526,633	10,406,454	1,999,503	1,388,776	26,091,096	5,713,538	45,599,367
1912	56,806,723	10,639,886	2,372,605	1,875,209	21,961,469	6,054,524	42,903,693
1913	48,563,985	10,380,813	2,326,931	1,196,169	22,227,408	6,974,106	43,105,427
1914	49,489,418	8,511,556	1,331,818	656,094	19,438,241	6,883,805	36,821,514
1915	51,757,419	7,029,846	844,297	374,181	27,223,899	8,679,248	44,151,471

Wells in the Baku oil fields, Russia, Dec. 31, 1914 and 1915.

Condition of wells.	Balakhani.		Sabunchi.		Romani.		Bibi-Eibat.		Total.	
	1914	1915	1914	1915	1914	1915	1914	1915	1914	1915
Completed	74	42	128	59	26	20	11	17	239	138
Producing	1,053	1,055	1,361	1,339	287	284	289	297	2,990	2,975
Trial pumping	6	6	20	6	1	4	10	3	37	19
Being drilled	61	55	61	68	60	65	58	43	240	231
Being drilled deeper	19	19	29	29	7	8	22	19	77	75
Cleaning out and repairing	42	42	86	75	51	52	58	50	237	219
Standing idle	360	418	738	867	275	310	207	253	1,580	1,848
Rigs up, ready for drilling	38	58	60	63	12	14	17	14	127	149
New wells sunk during year	64	38	104	65	34	42	13	14	215	159
Length of wells drilled, in feet	89,873	76,090	154,364	122,458	60,011	81,410	59,843	53,711	364,091	333,669

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Stocks of petroleum in Baku, Russia, Dec. 31, 1911–1915, in barrels.

	1911	1912	1913	1914	1915
At oil wells: Crude	906,625	952,676	1,068,427	1,099,851	972,389
At refineries:					
Crude	1,887,270	2,551,577	2,081,428	3,587,960	3,791,597
Illuminating	1,028,885	1,268,626	1,144,663	1,401,197	1,517,912
Lubricating	272,170	260,397	260,599	253,127	364,132
Residuals	3,196,771	3,396,775	2,817,656	4,625,735	4,125,300
Other products	306,825	443,643	374,909	446,274	358,150
	7,597,546	8,873,694	7,747,682	11,414,144	11,129,480

Well record in the Grosny oil field, Russia, 1911–1915.

Year.	Number of plots.		Total wells.	Producing Dec. 31.	Being bored or deepened Dec. 31.	Average depth of wells (feet).	Total length of wells drilled in the year (feet).
	Producing.	Being exploited.					
1911	80	195	358	195	61	1,670	72,933
1912	.....	223	402	264	71	1,752	119,165
1913	83	280	554	352	116	1,798	201,867
1914	86	315	665	435	123	1,885	275,814
1915	.....	393	.....	.....	.....	.....	168,000

Crude petroleum on hand in Grosny field Jan. 1, 1910, 285,829 barrels; Dec. 31, 1910, 787,949 barrels; Dec. 31, 1911, 141,649 barrels; Dec. 31, 1912, 245,583 barrels; Dec. 31, 1913, 533,153 barrels.

Petroleum shipped from Novorossisk, Russia, 1911–1915, in metric tons.

Year.	Crude oil.	Illuminating.[a]	Benzine.	Residuals.	Total.
1911	18,690	62,044	65,520	76,092	222,346
1912	.....	90,444	123,098	24,817	238,359
1913	.....	69,216	120,000	20,973	210,189
1914	228	15,966	.....	16,087	32,281
1915	2,758	1,212	.....	4,088	8,058

[a] Refined.

Stocks of petroleum at Novorossisk, Russia, Dec. 31, 1912, 1913, and 1915.[a]

	1912		1913		1915	
	Poods.	Barrels.	Poods.	Barrels.	Poods.	Barrels.
Crude	72,000	8,643	100,600	12,077	.....	.....
Illuminating oils	443,400	55,425	738,100	92,263	584,300	70,144
Astatki	230,000	25,555	839,000	93,222	23,900	2,889
Other products	1,073,900	127,845	1,736,500	207,281	52,700	6,327
	1,819,300	217,468	3,414,200	404,843	660,900	79,340

[a] Figures for 1914 not available.

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Petroleum shipped from Batum, Russia, 1911–1915.

Year.	Refined, petroleum.	Lubricating.	Residuals.	Total.
	Metric tons.	*Metric tons.*	*Metric tons.*	*Metric tons.*
1911	353,518	171,725	57,282	582,525
1912	327,338	188,804	53,300	569,532
1913	454,165	183,180	62,594	699,939
1914	240,162	83,638	31,809	355,609
1915	888	34	267	1,189

Stocks of petroleum at Batum, Russia, Dec. 31, 1911–1915.

	1911		1912		1913		1914.[a]		1915	
	Poods.	*Bbls.*	*Poods.*	*Bbls.*	*Poods.*	*Bbls.*	*Poods.*	*Bbls.*	*Poods.*	*Bbls.*
Illuminating	2,216,007	278,251	3,384,654	423,082	1,777,723	222,215	.....	.....	237,000	27,251
Lubricating	888,605	108,631	2,009,475	245,657	1,458,011	178,240	.....	.....	1,313,000	157,623
Solar oil, Vaseline, Residuals	300,585	35,880	963,794	107,088	1,063,459	118,162	.....	.....	1,713,000	205,642
	3,405,197	422,762	6,357,923	775,827	4,299,183	518,617	2,418,000	290,276	3,253,000	390,516

[a] Details for 1914 not available.

GALICIA.

GENERAL STATEMENT.

For the petroleum industry of Galicia the year 1915 was one of uncertainty and disaster as a consequence of the enormous military importance of the areas of oil production in that country. About the middle of September, 1914, the Boryslaw-Tustanowice district was occupied by the Russian armies. During the Russian occupation field work, which was abruptly curtailed at the beginning of the war, was resumed to about 50 per cent of its normal proportions, though little refining was done. As a consequence field stocks of crude petroleum increased so that by the middle of May they were reported to have amounted to 6,000,000 barrels.

After the Russian line in southeastern Galicia was broken by the Austro-German armies in May, 1915, the fate of the petroleum industry there became grave. For military reasons the retreating Russian armies set fire to a large number of oil wells in the Tustanowice district and burned a considerable part of the petroleum stored in the East Galician fields. According to the Frankfort Gazette, 229 wells out of a total of 319 were destroyed in the Tustanowice district and about 2,300,000 barrels of crude petroleum were burned.

After the Austro-German occupation of the fields in May steps were immediately taken to restore the damaged wells and refineries and place the petroleum industry on a sound basis. This work of rehabilitation required considerable time, but before the end of 1915 a decided increase in the rate of oil production was recorded. Drilling activity was limited mainly to restoring damaged wells to the status of producers and to the completion of wells that were in progress at the time of the Russian retreat, little effort being made to start new wells.

In order to avoid the uncertainties of railway transportation on lines already overburdened with military transport, a pipe line 40

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miles in length was constructed between Drohobycz and Chyrow to facilitate the distribution of crude petroleum from the Boryslaw-Tustanowice district to the refineries in the vicinity of Lemberg.

PRODUCTION.

Petroleum produced in Galicia, 1911–1915, in metric tons.[a]

Field.	1911	1912	1913	1914	1915
East Galicia:					
Tustanowice	1,105,420	856,440	691,382	[b]356,447	
Boryslaw	197,320	170,500	205,904	[b]116,613	
Schodnica					
Urycz					
Mraznica					
Other fields					
West Galicia:					
Potok	160,200	160,067	190,000	.....	578,388
Rogi					
Rowne					
Krosno					
Tarnawa-Wielopole-Zagorz					
Kobylanka, Kryg, Zalawie, Lipinki, Libusza, etc					
	1,462,940	1,187,007	1,087,286	[c]700,000	578,388

[a] 1 metric ton = 7.1905 barrels of crude petroleum of 42 gallons = 2,204.62 pounds.
[b] Figures for first six months only.
[c] Estimated.

Petroleum produced in Galicia, 1906–1915.

Year.	Metric centners.[a]	Barrels of 42 gallons.	Year.	Metric centners.[a]	Barrels of 42 gallons.
1906	7,604,432	5,467,967	1911	14,629,400	10,519,270
1907	11,759,740	8,455,841	1912	11,870,070	8,535,174
1908	17,540,220	12,612,295	1913	10,872,960	7,818,130
1909	20,767,400	14,932,799	1914	[b]7,000,000	5,033,350
1910	17,625,600	12,673,688	1915	5,783,880	4,158,389

[a] 1 metric centner or quintal = 100 kilograms (220.462 pounds); 1 metric centner or quintal of crude petroleum = 0.71905 barrel of 42 gallons.
[b] Estimated.

IMPORTS AND EXPORTS.

Petroleum imported into and exported from Austria-Hungary in 1911–1913,[a] *in metric tons.*

Kind.	1911		1912		1913	
	Imports.	Exports.	Imports.	Exports.	Imports.	Exports.
Illuminating oils	1,517	265,378	1,377	383,183	1,866	285,445
Lubricating and other oils	18,213	91,065	19,687	155,583	27,037	155,907
Benzine	10	41,904	89	68,606	2,683	49,773
Paraffin	631	37,940	546	51,594	200	42,101
Crude petroleum	19,020	610	17,873	1,660	19,134	1,112
Ozokerite	.....	.....	150	2,525	146	2,275
Ceresin	.....	.....	39	1,712	16	1,550
	39,391	436,467	39,761	664,955	51,184	539,163

[a] Statistics for 1914 and 1915 not available.

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ROUMANIA.

GENERAL STATEMENT.

Notwithstanding the great difficulties encountered by the petroleum industry in Roumania since the beginning of the European war, including scarcity of labor, shortage of drilling materials, partial cessation of exports, and accumulating stocks, the output of petroleum from the oil fields of that country in 1915 declined but little from the output in 1914.

In Prahova and Dambovitza, the districts most favorably situated with regard to refining facilities, conditions of production were essentially normal because kerosene, lubricating oils, and gas oils were free for exportation, though crude oil, benzine, and residuals were prohibited from such disposition. In the Buzeu and Bacau districts, however, from which it is necessary to transport the crude petroleum to the refineries in tank wagons, a notable decrease in production was recorded.

In commenting on the relatively slight decrease in Roumania's oil production in 1915, the Moniteur du Petrole Roumain ascribes the excellent showing to the ability of the Roumanian industry to adapt itself readily to new and unforeseen circumstances and, because of its perfect organization, to overcome quickly the extraordinary difficulties resulting from the great war.

Owing to the high cost of drilling materials and to the general depression in the petroleum industry, drilling activity in the Roumanian fields was below normal proportions in 1915. Nevertheless considerable exploration work was accomplished. Substantial additions were made to the productive area of the Stavropoleos field at its northern end and the new deep-sand sections of the Bana-Moreni field received considerable attention. Exploration in the new field at Ochiuri, in the Department of Dambovitza, discovered by the Astra-Romana Co. (Dutch-Shell Syndicate) in 1914, resulted in the completion of a number of good wells that added materially to the output credited to this department and demonstrated the opening of a profitable field.

The decline in output in the Bustenari field is ascribed, on the one hand, to the natural exhaustion of the old wells and, on the other hand, to the fact that only a slight amount of new drilling was done during the year. In the southwestern part of this field, however, exploration work has revealed the presence of rich oil sands, the ultimate development of which will doubtless serve to increase greatly the output of this field.

In the Baicoi division of the Bana-Moreni field production was greatly increased as a consequence of drilling activity in the Ferbatori extension. Important tests were reported in progress at the close of 1915 at Floresti, on the Baicoi-Ferbatori extension; at Ocnitza-Copatshishi, west of Moreni; at Piscuri, northwest of Moreni; and at Scaioshi, Cosminele, and Pacuretzi.

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PRODUCTION.

Petroleum produced in Roumania in 1914 and 1915, in metric tons.[a]

1914.

Month.	Prahova.					Dambovitsa.	Buzeu.	Bacau.	Total.
	Bustenari-Calinet-Bordeni.	Campina Poiana.	Moreni.	Other.	Total.				
January	21,951	15,446	70,450	10,489	118,336	4,552	13,535	3,551	139,974
February	22,980	13,804	67,100	9,318	113,202	3,503	12,280	3,488	132,473
March	24,771	16,617	88,082	10,624	140,094	3,533	14,065	4,141	161,833
April	22,707	16,449	79,404	8,624	127,184	2,962	13,834	3,995	147,975
May	24,347	15,833	76,491	9,367	126,038	2,976	14,243	4,229	147,486
June	26,542	16,820	74,153	9,943	127,158	3,028	13,926	4,683	148,775
July	27,529	14,494	73,184	12,699	127,906	3,285	13,646	4,068	148,905
August	23,044	14,253	68,039	13,727	119,063	2,956	10,659	4,542	137,220
September	21,758	13,813	60,593	15,121	111,285	4,070	9,774	4,388	129,517
October	24,740	13,543	81,678	18,464	138,425	6,584	11,909	4,329	161,247
November	27,042	12,207	74,300	15,544	129,093	5,757	8,871	4,163	147,884
December	26,576	11,534	82,622	38,011	158,743	5,962	11,673	4,280	180,658
	293,987	174,513	896,096	171,931	1,536,527	49,168	148,415	49,837	1,783,947

1915.

January	24,148	10,909	81,072	33,489	149,618	8,232	7,548	3,413	168,811
February	22,555	10,186	59,248	27,019	119,008	8,557	7,415	3,306	138,286
March	23,806	11,132	80,981	29,084	144,953	9,691	5,462	2,302	162,408
April	25,074	10,795	68,147	31,295	135,311	8,182	5,462	1,761	150,716
May	25,498	11,172	68,681	26,997	132,348	8,673	6,944	1,773	149,738
June	24,624	10,541	58,529	20,973	114,667	8,995	10,999	1,944	136,605
July	24,557	10,639	57,470	18,083	110,749	8,797	12,557	2,354	134,457
August	22,949	10,884	53,335	18,272	105,440	7,449	13,517	2,402	128,808
September	22,294	9,524	56,601	18,293	106,712	7,290	12,354	2,498	128,854
October	24,609	9,370	56,299	21,462	111,740	9,160	11,584	2,519	135,003
November	23,454	9,252	47,940	24,079	104,725	8,432	10,407	2,605	126,169
December	22,467	6,253	52,360	14,441	96,021	7,366	7,849	2,054	113,290
	286,035	120,657	741,163	283,437	1,431,292	100,824	112,098	28,931	1,673,145

[a] 1 metric ton = 7.19 barrels of 42 gallons.

Statistics of the petroleum industry in Roumania, 1911–1915, in metric tons.

	1911	1912	1913	1914	1915
Crude oil produced	1,544,847	1,804,761	1,885,225	1,783,947	1,673,145
Crude oil treated at refineries	1,404,403	1,667,389	1,787,245	1,680,894	1,580,951
Output of refineries:					
Benzine	260,653	352,492	422,019	396,865	394,809
Illuminating oil	312,711	345,802	380,074	352,682	263,633
Lubricating oil	24,703	43,438	48,416	100,047	129,685
Residuals	733,136	898,011	906,735	807,276	765,676
Home consumption:					
Benzine	24,450	30,656	30,131	31,672	31,762
Illuminating oil	43,941	49,941	51,396	51,710	52,741
Lubricating oil	22,401	26,997	33,725	40,816	48,348
Paraffin	1,144	1,138	1,425	1,416	1,849
Residuals	434,094	540,385	560,492	524,254	501,943
Fuel at the refineries	123,029	140,590	135,728	134,324	166,189
Exports:					
Benzine	124,384	173,817	237,168	164,143	13,132
Illuminating oil and distillate	318,441	353,563	418,622	297,800	272,989
Crude, residuals, etc	233,865	318,443	380,077	191,545	142,816
Paraffin	476	600	579	536	243
Stocks on hand Dec. 31:					
Crude (pipe line and refinery)				[a] 200,000	[a] 250,000
Benzine	51,862	60,647	66,746	[a] 500,000	[a] 800,000
Illuminating oil	73,908	126,009	145,466		
Lubricating oil and residuals	248,375	227,140	79,766		

[a] Approximate.

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Percentages of petroleum produced in Roumania, 1911–1915, by departments.

Department.	1911	1912	1913	1914	1915
Prahova	89.67	89.51	89.00	86.03	85.54
Dambovitza	4.47	4.11	2.21	2.78	6.03
Buzeu	4.08	4.83	6.66	8.38	6.70
Bacau	1.78	1.55	2.13	2.81	1.73
	100.00	100.00	100.00	100.00	100.00

Percentages of refined products from Roumanian crude petroleum, 1911–1915.

Product.	1911	1912	1913	1914	1915
Crude benzine	18.6	21.2	23.6	23.6	24.9
Illuminating oil	22.3	20.7	21.3	21.0	16.7
Lubricating oil	1.8	2.6	2.7	5.9	8.2
Residue	55.8	53.8	50.7	48.0	48.5
Loss	1.5	1.7	1.7	1.5	1.7

Wells completed in Roumania in 1915.

District.	Jan. 1, 1915.						Dec. 31, 1915.					
	Bore holes.			Hand wells.			Bore holes.			Hand wells.		
	Producing.	Being drilled.	Abandoned.	Producing.	Being drilled.	Abandoned.	Producing.	Being drilled.	Abandoned.	Producing.	Being drilled.	Abandoned.
Prahova	303	312	600	99	203	316	305	294	548	93	235	312
Dambovitza	26	15	20	44	2	48	85	30	41	44	1	47
Buzeu	75	41	35	59	17	145	21	27	14	56	21	144
Bacau	84	12	15	360	22	462	65	11	40	360	22	462
	988	380	670	562	244	971	976	362	643	553	279	965

Petroleum products exported from Roumania in 1911–1915, in metric tons.

Kind.	1911	1912	1913	1914	1915
Crude oil, gas oil, lubricating oil, and residuals	233,895	318,443	380,077	191,545	142,813
Illuminating oil	318,441	353,563	418,622	297,800	272,900
Benzine	124,384	173,817	237,168	164,143	13,131
Paraffin scale	476	600	579	536	243
	677,196	846,423	1,036,446	654,024	429,087

BRITISH ISLES.

Oil shale.—The deposits of oil shale in southern Scotland are the only commercially important source of petroleum thus far developed in the British Isles. Although the yield averages only 25 United States gallons of oil to the ton of shale retorted, the Scottish shale industry has been an important one for more than 40 years because of the valuable by-products, sulphate of ammonia and paraffin wax, of the shale works.

Despite the fact that the shale-oil industry in 1915 was beset with difficulties in the matter of increased costs of labor, chemicals, and

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supplies, the enhanced prices for all oils and by-products more than offset these factors and left the industry in a prosperous condition at the close of the year.

Economical operation, whereby every ton of shale is realized to the utmost percentage, and the policy of setting aside large sums for improvements in past years account in part for the strong position of the shale-oil companies at the end of 1915, according to the Petroleum Review,[1] which describes developments during that year in part as follows:

By the introduction of labor-saving machinery, the employment of electric power in all departments on the surface and below in the mines, new retort installations, and new chemical appliances, the companies are in a position to earn dividends. Shale fields are being opened and the increase in output aids in profit making. The Oakbank Co. took over the Dalmeny Co.'s works and shale fields and has now concluded arrangements with the Crown to mine shale under the sea, where the beds are extensive and rich.

Oil shale produced in Great Britain, 1906–1915.

Year.	England.		Scotland.		Wales.		Total.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1906	.....	.....	2,545,724	$3,200,449	798	$1,358	2,546,522	$3,201,807
1907	.....	.....	2,690,028	3,923,971	.....	.....	2,690,028	3,923,971
1908	.....	.....	2,892,039	3,870,118	.....	.....	2,892,039	3,870,118
1909	40	34	2,967,017	3,970,723	.....	.....	2,967,057	3,970,757
1910	.....	.....	3,130,280	4,189,114	.....	.....	3,130,280	4,189,114
1911	.....	.....	3,116,803	4,171,174	.....	.....	3,116,803	4,171,174
1912	.....	.....	3,184,826	3,726,425	.....	.....	3,184,826	3,726,425
1913	.....	.....	3,279,903	4,001,839	240	341	3,280,143	4,002,180
1914	.....	.....	3,268,666	4,074,472	.....	.....	3,268,666	4,074,472
1915[a]	.....	.....	3,300,000	4,500,000	.....	.....	3,300,000	4,500,000

[a] Estimated.

GERMANY.

The Geological Survey has been unable to obtain statistics of the production of petroleum in Germany in 1915.

Production from the petroliferous areas in Alsace-Lorraine and Hanover has doubtless increased since the beginning of the European war, but neither confirmation of this assumption nor any basis for estimating the magnitude of such increase is available.

Petroleum produced in the German Empire, 1906–1915.

Year.	Alsace-Lorraine.	Prussia.	Total.		Total value.	
	Metric tons.	*Metric tons.*	*Metric tons.*	*Barrels (42 gallons).*	*Marks.*	*Dollars.*
1906	[a] 22,154	59,196	81,350	578,610	5,036,000	1,198,568
1907	[a] 26,124	80,255	106,379	756,631	7,056,000	1,679,328
1908	[a] 28,898	113,002	141,900	1,009,278	9,942,000	2,366,196
1909	[a] 29,726	113,518	143,244	1,018,837	10,118,000	2,408,084
1910	.....	.....	145,168	1,032,522	10,146,000	2,414,748
1911	.....	.....	142,992	1,017,045	10,045,000	2,390,710
1912	.....	.....	144,961	1,031,050	10,190,000	2,425,220
1913	.....	.....	[b] 140,000	995,764	9,790,285	2,330,088
1914	.....	.....	[b] 140,000	995,764	9,790,285	2,330,088
1915	.....	.....	[b] 140,000	995,764	9,790,285	2,330,088

[a] Includes Bavaria.

[b] Estimated.

1 metric ton, crude = 7.1126 barrels.

[1] Petroleum Rev., vol. 34, No. 723, p. 433, May 27, 1916.

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ITALY.

Scarcity of fuel and consequent high prices have been responsible for a revival of drilling activity in the petroleum fields of Italy. Considerable importance is attached to developments in the Rivanazzano field, in the Province of Pavia, where operations in 1914 and 1915 revealed the presence of a source of oil superior to that produced in other Italian fields in that it contains appreciable percentages of the lubricating and grease fractions, which are absent in other grades of petroleum produced in that country. The scarcity and high cost of drilling supplies resulting from the war tended to hamper operations in the Italian fields in 1915.

The following statistics are taken from the Revista del servizio minerario:

Petroleum produced in Italy, 1906–1915.

Year.	Number of wells in operation.	Quantity.		Value.	
		Metric tons.[a]	United States barrels.	Lire.[b]	Dollars.
1906	12	7,451	53,577	2,226,559	429,726
1907	13	8,327	59,875	1,663,300	321,017
1908	14	7,088	50,966	1,415,640	273,219
1909	12	5,895	42,388	1,178,060	227,481
1910	9	7,069	50,830	1,413,800	272,863
1911	9	10,390	74,709	1,454,600	280,737
1912	9	7,479	53,778	1,196,640	230,952
1913	9	6,564	47,198	1,641,000	316,713
1914	7	5,542	39,849	1,385,500	267,402
1915[c]	7	5,500	39,548	1,000,000	193,000

[a] 1 metric ton, crude=7.1905 barrels. [b] 1 lira=$0.193. [c] Estimated.

PERSIA.

Active development of the petroleum resources of Persia is at present conducted by the Anglo-Persian Oil Co. (Ltd.) and its subsidiaries, in which the English Government acquired a majority interest in 1914.

The concession of this company covers an area of some 500,000 square miles in southern and western Persia. Oil has been found in quantity at Maidan-i-Naphtun and its presence proved at Kasr-i-Shirin. Oil indications have been observed at White Oil Springs, Kishm, Daliki, Ahmadi, Rudan, Kuh Champa, and elsewhere. Production is obtained at present entirely from the Maidan-i-Naphtun field, which is about 50 miles northeast of Ahwaz, on the Karun River, and 140 miles north-northeast of Mohammerah. In this field 32 wells have been drilled, of which only 12 have been completed.

From Maidan-i-Naphtun the oil is conveyed about 145 miles by pipe to a refinery on the island of Abadan at the head of the Persian Gulf. The pipe line is 6 inches in diameter as far as Wais (53 miles) and 8 inches from there to Abadan and has an estimated capacity of 1,000 tons of oil a day. A new pipe line with about three times this capacity is under construction.

The refinery at Abadan, which has 34 stills in operation, produces gasoline, kerosene, and fuel oil, and has an estimated capacity of 400,000 tons of crude oil a year.

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According to the Neftannoie Dielo concessions for exploration of petroleum, gas, asphalt, and ozokerite in the districts of Tunelsabun, Kujur, and Kalalestag, in northern Persia, originally granted in 1896 to Mr. Sapekhdar, were in March, 1916, transferred to A. M. Khoshtaria.

By the terms of this transfer Mr. Khoshtaria is reported to obtain a monopoly for exploration and exploitation of petroleum for a period of 70 years. He is also granted the right to import free of duty all necessary supplies and machinery for producing, refining, and transporting petroleum and is authorized to install the same on lands gratuitously provided by the Government for that purpose.

In return for these concessions Mr. Khoshtaria is required to pay the Persian Government 16 per cent on all profits and also to pay a specially appointed state controller a yearly salary of 6,000 rubles ($3,090).

TURKEY.

In a review of the economic development in Palestine in 1914 the American consul at Jerusalem, O. A. Glazebrook,[1] reports on the prospects of oil development in that country as follows:

> After several examinations and surveys the Standard Oil Co. of New York purchased from three natives seven concessions for the exploitation of the oil fields in Turkey, southwest of the Dead Sea, as well as the sulphur, bitumen, and phosphate deposits in the neighborhood areas.
>
> It is reported that the American company set aside about $300,000 for surveying and trying these areas and sent a staff of managers, engineers, and workmen to start work. A shipload of the necessary boring machinery and supplies, with eight automobiles, was well under way and about to reach Alexandria when the war broke out.
>
> Necessarily all these improvements and industries had to be postponed indefinitely, the ship having been unloaded and the goods warehoused at Alexandria, Egypt.

BRITISH INDIA.

Operations in the oil fields of Burma, Assam, and Punjab failed to result in any developments of consequence in 1915. Deeper drilling in the Yenangyoung field, in Burma, failed to yield the satisfactory results expected, and in order to maintain production a number of new wells were drilled.

In Assam the Digboi field continued to supply the bulk of the oil produced. About 2 miles east of this field prospecting has demonstrated the presence of a new field, designated Bappa Poong, of considerable promise, and 3 miles farther to the east an initial test in an area called the Hansa Poong field was reported to have furnished evidence of still another field.

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[1] Oil City Derrick, issue of June 22, 1915.

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Petroleum produced in India, 1906–1915.

Year.	Quantity.		Value.	
	Imperial gallons.	Barrels (42 United States gallons).	Rupees.[a]	Dollars.
1906	140,553,122	4,015,803	8,613,576	2,790,799
1907	152,045,677	4,344,162	9,150,225	2,968,637
1908	176,646,320	5,047,038	10,530,135	3,416,327
1909	233,678,067	6,676,517	13,652,580	4,429,352
1910	214,829,647	6,137,990	12,538,905	4,068,039
1911	225,792,094	6,451,203	13,265,970	4,303,923
1912	249,083,518	7,116,672	14,629,170	4,746,190
1913	277,555,225	7,930,149	15,518,790	5,035,803
1914	259,342,710	7,409,792	14,378,475	4,664,857
1915[b]	287,093,576	8,202,674	18,852,045	6,116,232

[a] The value of the rupee is taken as 32.44½ cents; 15 rupees=£1.

Petroleum produced in India, 1911–1915, in imperial gallons.

Province.	1911	1912	1913	1914	1915
Burma	222,225,531	245,335,209	272,965,397	254,652,963	282,291,982
Eastern Bengal and Assam	3,565,163	3,747,359	4,688,628	4,688,547	4,550,150
Punjab	1,400	950	1,200	1,200	251,494
	225,792,094	249,083,518	277,555,225	259,342,710	287,093,476

CHINA.

During the greater part of 1915 test work was carried on by the Standard Oil Co. of New York in the Yenchang district, in Shensi Province, under its agreement with the Republic of China entered into on February 10, 1914. In accordance with this agreement the Standard Oil Co. was to send experts to make a thorough investigation of the Yenchang, Yenanfu, and adjoining areas in Shensi and the Chengtehfu district in Chihili, the cost to be borne by the oil company and the Government jointly. If these investigations showed that the fields could be worked to advantage, an American company was to be formed. If the fields proved valueless other districts were to be explored. For a period of one year no petroleum concessions were to be granted to other foreigners. Although this agreement terminated February 10, 1915, it was extended from time to time in order that the prospective areas might be given a thorough test. Unofficial reports are to the effect that three wells were drilled in 1915, one of which yielded a fair showing of oil, though the other two were barren.

JAPAN.

GENERAL STATEMENT.

An appreciable gain in production of petroleum is credited to Japan in 1915, the output in that year exceeding 3,000,000 barrels for the first time in the history of the country.

Credit for the increase belongs chiefly to the Kurokawa field, in the prefecture of Akita, where, duplicating its record in 1914, the Nippon Oil Co. brought in a prolific gusher on May 24 half a mile north of the

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big well completed on May 25, 1914. Although the initial flow of the new well which was estimated at 3,000 barrels a day was considerably less than that of the big well, its reported location on the same anticline is important as essentially proving the oil character of the intervening territory.

Despite the increase credited to Akita the bulk of Japan's oil production is still derived from the important fields in Echigo (Niigata).

In commenting on the Japanese industry in 1915 the Petroleum Times (Tokyo, December, 1915) states:

A notable tendency of operators this year was toward getting more money out of oil aboveground rather than getting more oil out of the ground. Introduction of the Russian system of continuous distillation, increase in the number of gasoline plants, and installation of a wax plant clearly prove this tendency.

The wax plant referred to, which is in the Naoyetsu refinery, is the first of its kind in Japan, and its successful operation is a source of gratification to the Nippon Oil Co., its owners. The plant has a capacity of 300 barrels of wax distillate a day and was supplied and installed by the Carbondale Manufacturing Co., Carbondale, Pa. The residuum used as the source of the wax is from crude petroleum produced in the Nishiyama and Kubiki fields.

PRODUCTION.

Petroleum produced in Japan,[a] 1906–1915.

Year.	Koku.[b]	Barrels.	Year.	Koku.[b]	Barrels.
1906	1,501,563	1,705,776	1911	1,529,593	1,737,618
1907	1,755,464	1,994,207	1912	1,458,290	1,656,617
1908	1,815,001	2,061,841	1913	1,693,582	1,923,909
1909	1,657,036	1 882,393	1914	2,395 836	2,721,670
1910	1,520,458	1,727,240	1915	2,728,476	3,099,549

[a] Exclusive of the island of Formosa.

[b] 1 koku=39.7 English gallons=47.46 United States gallons=1.136 United States barrels.

The following figures are reported by the imperial mining bureau of the department of agriculture and commerce, Tokyo:

Petroleum produced in Japan and Formosa, 1911–1915, in koku.

Field.	1911	1912	1913	1914	1915
Akita	25,090	31,365	76,830	625,719	980,223
Hokkaido	1,358	5,038	4,218	6,270	8,846
Nagano	55	.....	.....	.....	.....
Niigata	1,500,482	1,419,539	1,610,117	1,761,792	1,728,667
Shizuoka	2,229	2,030	1,983	2,055	1,790
Yamagata	356	205	336	.....	.....
Kagoshima	23	.....	.....	.....	.....
Others	.....	113	98	.....	.....
	1,529,593	1,458,290	1,693,582	2,395,836	2,728,476
Formosa	1,442	3,040	15,933	14,708	16,651
Grand total	1,531,035	1,461,330	1,709,515	2,410,544	2,745,127

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Petroleum produced in Japan and Formosa, 1906–1915.

Year.	Japan.		Formosa.		Total.	
	Koku.	*Barrels.*	*Koku.*	*Barrels.*	*Koku.*	*Barrels.*
1906	1,501,563	1,705,776	4,394	4,992	1,505,957	1,710,768
1907	1,755,464	1,994,207	a 6,717	7,631	1,762,181	2,001,838
1908	1,815,001	2,061,841	7,310	8,304	1,822,311	2,070,145
1909	1,657,036	1,882,393	5,664	7,170	1,662,700	1,889,563
1910	1,520,458	1,727,240	3,208	4,062	1,523,664	1,730,882
1911	1,529,593	1,737,618	1,442	1,638	1,531,035	1,739,256
1912	1,458,290	1,656,617	3,040	3,454	1,461,330	1,660,071
1913	1,693,382	1,923,909	15,933	18,100	1,709,515	1,942,009
1914	2,395,886	2,721,670	14,708	16,708	2,410,544	2,738,378
1915	2,728,476	3,099,549	16,651	18,915	2,745,127	3,118,464

a Estimated.

AFRICA.

EGYPT.

The production of petroleum in Egypt is restricted to the concessions of the Anglo-Egyptian Oilfields (Ltd.), in the vicinity of Gemsah, on the west shore of the Red Sea, near the confluence of the Red Sea and the Gulf of Suez. The wells thus far drilled in the Gemsah field have proved short lived, and deeper drilling has been resorted to in efforts to prolong production. Government licenses over areas at Hurgada, south of Gemsah, were acquired in 1913 and in October, 1914, oil was struck in well No. 1 at a depth of 1,670 feet. Other wells have been sunk in the new district, No. 7 being completed in December, 1915.

Storage tanks with a capacity of 60,000 to 70,000 tons of oil have been provided at Gemsah and Suez, and at Suez a refinery having a capacity of 500 tons of oil a day is in operation.

Petroleum produced in Egypt, 1911–1915.

Year.	Metric tons.	Barrels of 42 gallons.
1911	1,220	9,150
1912	27,454	205,905
1913	12,618	94,635
1914	103,605	777,038
1915	29,569	221,768

MADAGASCAR.

During the year 1915 drilling operations were carried on in the search for oil in the Betsiriry Valley, Madagascar, by the Betsiriry Proprietary Oil Fields (Ltd.), which in 1914 acquired the assets of the Taylor-Coryell Madagascar Petroleum Syndicate, and by the Sakalava Madagascar Proprietary Oil Fields (Ltd.). No discoveries of commercial importance were reported.

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OCEANIA.

EAST INDIES.

The moderate increase in production of petroleum in the East Indies was well distributed among the producing areas in Borneo, Java, Sumatra, and Ceram, all of which are credited with quantities in excess of the yield in 1914. No important developments were recorded in the older fields of the Dutch possessions.

In British territory exploration was continued in the States of North Borneo and Brunei, on the island of Borneo, by American interests. Oil in small quantities is reported to have been found in both States and additional tests will undoubtedly be drilled. In the Miri field, Sarawak (British), on the north coast of Borneo, a slight but encouraging increase in production was recorded. Construction work was started on a refinery adjacent to this field and on a deep-sea pipe line to facilitate the loading of steamers.

In Papua, or New Guinea, a test well at Upoia, in British territory, drilled under the supervision of the commissioner of lands and director of mining for Papua yielded small quantities of petroleum at a shallow depth, and deeper drilling was undertaken in the hope of obtaining commercial production at depths of 1,000 to 1,500 feet. The prospective oil area in Papua is estimated to be 1,000 square miles in extent.

Petroleum produced in Dutch East Indies, 1906–1915.

Year.	Borneo.		Java.		Sumatra.		Total.		
	Metric tons.	Liters.	Metric tons.	Liters.	Metric tons.	Liters.	Metric tons.	Liters.	Barrels.
1906....	387,455	429,275,398	111,378	129,229,083	602,501	742,097,300	1,101,334	1,300,601,781	8,180,657
1907....	489,151	541,948,068	142,983	165,900,000	713,841	879,235,063	1,345,975	1,587,083,131	9,982,597
1908....	511,049	566,209,890	137,013	158,974,000	738,588	909,715,827	1,386,650	1,634,899,717	10,283,357
1909....	411,506	455,922,397	140,351	162,846,428	922,894	1,136,720,015	1,474,751	1,755,488,840	11,041,852
1910....	633,472	701,853,114	142,503	165,344,877	719,740	886,505,130	1,495,715	1,753,703,121	11,030,620
1911....	814,707	902,654,621	172,438	190,766,435	683,523	841,895,279	1,670,668	1,935,316,335	12,172,949
1912....	671,662	744,167,950	184,989	214,641,699	621,481	765,481,929	1,478,132	1,724,291,578	10,845,624
1913....	797,059	883,061,666	207,135	240,334,598	529,947	652,735,720	[a]1,534,223	1,776,227,127	11,172,294
1914....	[c]931,903	1,032,455,334	226,590	262,907,845	475,423	585,578,509	[b]1,634,403	1,881,506,744	11,834,492
1915....	[d]960,896	1,064,576,678	256,838	298,003,995	491,611	605,517,269	[e]1,710,445	1,969,316,632	12,386,808

[a] Includes 82 metric tons produced in Ceram.
[b] Includes 487 metric tons produced in Ceram.
[c] Includes 65,185 metric tons produced in British Borneo.
[d] Includes 67,000 metric tons produced in British Borneo.
[e] Includes 1,100 metric tons produced in Ceram.

1 gallon Borneo crude=7.5322 pounds.
1 gallon Java crude=7.1924 pounds.
1 gallon Sumatra crude=6.7754 pounds.
1 United States barrel=158.985 liters; 1 liter=1.0567 quarts.

AUSTRALIA.

SOUTH AUSTRALIA.

The year 1915 marks the beginning of actual drilling operations in South Australia to determine whether or not oil pools exist in that country. Effort toward this end in 1915 was concentrated on the coastal district adjacent to Robe and Kingston, where surface indications of petroleum have been reported. Reports from the Robe well in November were to the effect that pockets of inflammable gas had been penetrated and that at a depth of 1,575 feet definite indications of oil had been encountered.

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QUEENSLAND.

Interest in the potentialities of the deposits of oil shale in the Baffle Creek district, near Lowmead, Queensland, resulted in the sinking of bore holes by a Sydney company holding leases in that district, one of which is reported to have penetrated a thick bed of suitable shale at 173 feet.

NEW SOUTH WALES.

The petroleum production of New South Wales is derived wholly from the distillation of oil shale by the British Australian Oil Co. and the Commonwealth Oil Corporation on leases in Capertee Valley, in the Blue Mountain region. The average recovery of oil is about 80 United States gallons to the ton of shale distilled.

Oil shale produced in New South Wales, 1906–1915.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1906	32,446	$138,549	1911	75,104	$179,963
1907	47,331	154,996	1912	a 86,018	169,208
1908	46,303	126,855	1913	a 16,985	35,715
1909	43,718	114,932	1914	50,049	133,205
1910	68,203	164,955	1915	a 50,000	133,000

a Estimated.

TASMANIA.

With regard to the potentialities of the deposits of oil shale in the island of Tasmania, the Australian Mining Standard (May 18, 1916) quotes as follows from a report by Dr. Arthur Wade on the properties of the Railton Latrobe Shale Oil Co.:

The minimum estimate of shale available on the company's property is 5,500,000 tons. The average yield of the three primary petroleum products obtained by distillation in the company's own retorts is over 40 gallons of crude oil per ton, over 7 gallons of petroleum spirit per ton, and 2,500 cubic feet of combustible gas per ton of shale. Since my first visit new retorts have been installed, and figures now show an excess, reaching 43 gallons of crude oil per ton of shale, and about 7½ gallons of spirit, which compares very favorably with the results from distillation of oil shales in other parts of the world. The petroleum contains about 1 per cent of chemically combined sulphur, which is 2 per cent below the maximum fixed by the British Admiralty. It is essentially fuel oil, and its calorific value is the highest in the world, a comparison showing the Tasmanian product to be one of the best fuel oils in existence.

NEW ZEALAND.

In a report dated November 17, 1915, Consul General Alfred A. Winslow, at Auckland, writes as follows concerning the status of the petroleum industry in New Zealand:

According to the published report of the New Zealand minister of mines and mining, there are in the country 15 borings for petroleum, varying from 1,375 to 4,040 feet in depth, of which five are producing more or less crude oil. It seems to be the general impression that more and better oil can be found farther down, and the New Zealand Government is encouraging its development.

The director of the Geological Survey in reporting to the minister of mines has the following to say about the future of the petroleum industry in this dominion:

"Practically all qualified observers are agreed in the belief that the source of the New Plymouth oil is at a great depth and that probably the principal oil horizon will

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not be found at a much less depth than 5,000 feet. Clearly, then, the future of the field depends on the result of deep boring, and bores less than 3,000 feet in depth will not be directly important in deciding whether Taranaki possesses a prolific oil field or not. They may, however, in places be moderately profitable, and may indirectly be of great value in furnishing the structural data of which at present there is so great a lack. The area most deserving of being prospected appears to be the strip of country that extends for 15 miles south-southeast from the Sugarloaves and contains somewhat numerous gas vents. So far as can be judged from the data at present known, the first deep bore ought to be in the neighborhood of Moturoa, where a considerable amount of oil has already been obtained. Had the area to the south-southeast already mentioned been more thoroughly prospected by means of 2,500 feet to 3,000 feet bores possibly this opinion would need modification."

The output to date has amounted to about 780,000 gallons, of which about 530,000 gallons have been refined.

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STONE.

By G. F. Loughlin.[1]

INTRODUCTION.

The present report on the stone industry contains, in addition to the usual statistical data, an account of the distribution and qualities of crushed stone. The statistical work, as in former years, has been greatly hindered by the failure of many producers to report the quantity as well as the value of stone quarried and by the lack of uniform units of measurement. This lack of uniformity has been a source of trouble to many engaged in the use or purchase of stone, and the adoption of uniform units of measurement in all the States should be urged by everyone interested in the stone industry. Failure of some producers to send their figures promptly delays publication of the report and correspondingly lessens its value. A few large companies do not close their accounts until February or March, but these are much more prompt than others. On May 1, 1916, fully 10 per cent of the producers of stone, including several large companies, had not reported, and it was not possible to complete the tables until late in July. If producers would send their figures in January or February, the report on stone could be completed in March.

The figures presented in the following report, as for previous years, have to do with the stone produced and sold or used by the quarrymen. They include only such manufactured product as is put on the market by the quarrymen themselves, comprising especially rough and dressed building stone, rough and dressed monumental stone, crushed stone, flagstone, curbstone, and paving blocks. The value given to the manufactured product is the price received by the producer free on board at point of shipment and therefore includes the cost of labor necessary to dress the stone. The stone reported as sold rough includes stone sold as rough stock to monumental works and to contractors of cut stone for building and stone sold as riprap, rubble, and flux. The value given to this stone is the price received by the quarrymen free on board at point of shipment, and includes the cost of only such labor as is required to get the stone out of the quarry in the shape required by the purchaser. If the stone is sold to local trade, the value is given as the quarrymen sell the material, generally at the quarry, but occasionally delivered, if delivery is made by the producer. In some places a long haul to market or to the railroad increases the cost of the material and therefore the selling price.

[1] The statistical part of this report is, as in former years, entirely the work of Miss A. T. Coons, of the U. S. Geological Survey.

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For simplicity of treatment the kinds of stone covered by the statistics in this report are classified as granite, basalt and related rocks (trap rock), marble, limestone, and sandstone.

"Granite" includes true granite as well as such allied rocks as monzonite, syenite, and gneiss and certain other igneous and metamorphic rocks which are quarried by too few producers to permit their production to be shown separately. The varieties of igneous rocks thus occasionally included under "granite" are mostly of the light volcanic type, such as tuff, rhyolite, trachyte, and andesite, but from time to time small quantities of dark igneous rocks, such as diorite and gabbro, are necessarily included with granite.

"Basalt and related rocks," heretofore included under the term "trap rock," comprise, besides typical basalt and diabase, fine-grained diorite, gabbro, and other basic rocks which are less common in occurrence but are similar in chemical and physical properties and are used largely as crushed stone.

"Marble" includes a small quantity of serpentine quarried and sold as marble in California, Georgia, Maryland, Massachusetts, Pennsylvania, and Vermont, and also a small quantity of the so-called onyx marble or travertine obtained from caves and other deposits in Kentucky and other States.

"Limestone" does not include limestone burned into lime, bituminous limestone, nor limestone entering into the manufacture of Portland cement.

"Sandstone" includes the quartzites of South Dakota, Minnesota, and Wisconsin and the fine-grained sandstones of New York and Pennsylvania, known to the trade as bluestone. As bluestone is the product of a distinct local industry, its production is also shown separately from that of the other sandstones. Bluestone is also quarried in New Jersey and West Virginia, but this product is small and is not separated from sandstone. In Kentucky most of the sandstone quarried and sold is known locally as freestone. The figures given for sandstone do not include the value of the grindstones, whetstones, and pulpstones made from sandstones quarried in Michigan, Ohio, and West Virginia; nor does the total value of sandstone include that of sandstone crushed into sand and used in the manufacture of glass and as molding sand. The production of these materials is set forth in other chapters in Mineral Resources.

UNIT OF MEASUREMENT.

Owing to the variety of uses to which stone is put, there is no regular unit of measurement employed by the quarryman, the stone being sold by the cubic yard, cubic foot, ton, cord, perch, rod, square foot, square yard, square, or other unit. Building and monumental stone, especially the dressed product, is usually sold by the cubic foot or the cubic yard, although this unit varies with the class of stone and with the locality. A large quantity of the rough stone is sold by the perch, cord, or ton. Rubble and riprap, including stone for such heavy masonry as breakwater and jetty work, are generally sold by the cord or ton. Fluxing stone and stone for chemical use—as for alkali works, sugar factories, carbonic acid plants, and paper mills—is sold by either the long or the short ton. Flag-

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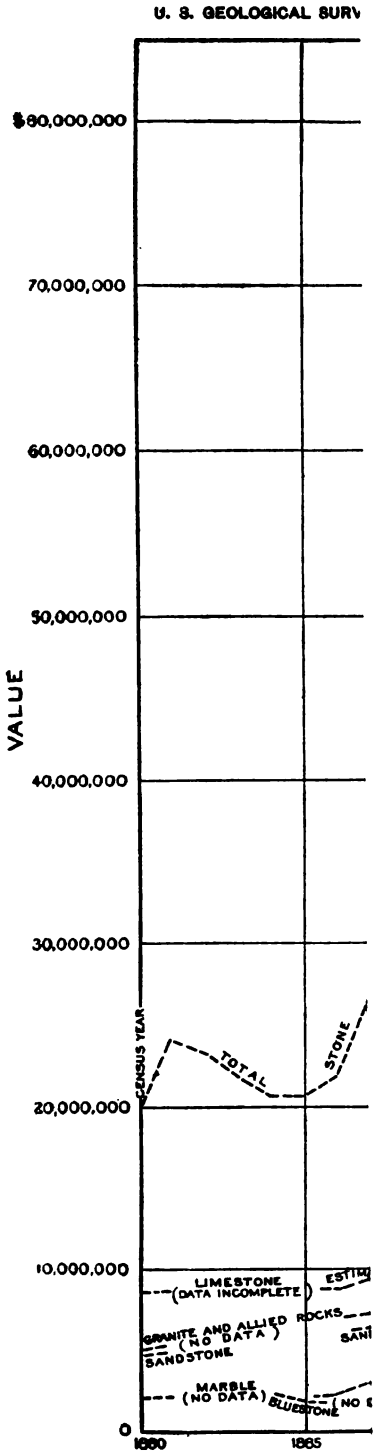

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stone and curbstone are sold by the square yard or the square foot, the thickness being variable and dependent on the orders received. Granite paving blocks are sold invariably by the number of blocks, but the blocks are not of uniform size, hence the value depends on the size and on the labor necessary to cut the block into the shape desired. Other paving material is sold by various units, such as the ton or cubic yard. Crushed stone is reported as sold by the cubic yard or ton, the short ton being more generally used.

The perch is legally defined in many older States as 24¾ cubic feet; in some States, and even within a single State, it varies from 16½ through 20, 22, 25 to 27 cubic feet; and in others it is defined as equivalent to 2,200, 2,500, 2,700, 2,800, and 3,000 pounds. The cord in some States is measured in feet—for instance, 128 cubic feet in the quarry or 100 feet in the wall; in others it denotes weight and is variously defined as equivalent to 11,000, 12,000, 12,500, and 13,000 pounds. The weight of a cubic yard of crushed stone varies from 2,300 to 3,000 pounds, the average weight being about 2,500 pounds. In certain localities this crushed stone is sold by the "square" of 100 square feet by 1 foot, or 100 cubic feet. It is also of interest to note the selling of crushed stone by the bushel, 21½ bushels representing a cubic yard of about 2,700 pounds. As most of the crushed-stone producers report the quantity according to some unit, it has been possible to convert the crushed stone into short tons, the unit which represents the larger number of producers and is the most convenient.

The stone industry as a whole, as shown in Plate VI, has advanced with the development of the country in spite of severe competition with brick, Portland cement, concrete, and certain other artificial stone products. The use of these materials has seriously affected the production of the lower grades of stone for foundations and to a less degree the production of building stone of higher grade, as shown in figure 26 (p. 827), but it has had little or no effect on the use of monumental stone. On the other hand, the use of concrete and the extensive building of roads and railroads have caused an increase in the production of crushed stone so enormous as to more than offset the decline in other kinds. This increase is shown in the diagram (Pl. VI) by the marked rise of the curves for limestone and basalt (trap rock) since 1900. It also accounts in part for the general rise of the curve for granite.

MARKETED PRODUCTION.

PRODUCTION BY KINDS OF STONE.

General statistics.—The total value of stone produced and sold in the United States continued to decrease in 1915, as shown in the accompanying table. The decrease in value for 1915 was $2,948,751, or 3.8 per cent, and followed a decrease in 1914 of 7.6 per cent from the record value of 1913. The value for 1915 was also less than that for any previous year since 1909.

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Value of stone sold in the United States, 1906–1915.

Year.	Granite.	Basalt and related rocks (trap rock).[a]	Sandstone.	Marble.	Limestone.	Total.
1906	$18,562,806	$3,736,571	$9,169,337	$7,582,938	$27,327,142	$66,378,794
1907	18,064,708	4,594,103	8,871,678	7,837,685	31,737,631	71,105,805
1908	18,420,080	4,282,406	7,594,091	7,733,920	27,682,002	65,712,499
1909	19,581,597	5,133,842	8,010,454	6,548,905	32,070,401	71,345,199
1910	20,541,967	6,452,141	7,930,019	6,992,779	34,608,678	76,520,584
1911	21,194,228	6,739,141	7,730,868	7,546,718	33,897,612	77,108,567
1912	19,223,302	7,560,049	6,893,611	7,788,458	36,729,800	78,193,220
1913	20,733,217	9,134,494	7,248,965	7,870,890	38,745,429	83,732,995
1914	20,160,730	7,865,998	7,501,808	8,121,412	33,894,155	77,544,103
1915	17,864,439	8,480,222	6,095,800	6,916,025	35,229,866	74,595,352
Percentage of increase or decrease for 1915	−11.4	+7.9	−18.7	−14.8	+3.9	−3.8
Percentage of total	23.9	11.4	8.2	9.3	47.2	100.00

[a] As the meaning of the term "trap rock" has been variously interpreted and has been made in some localities to include a number of widely different rocks, it is here replaced by the title "basalt and related rocks."

The decrease in 1915 was due to a continuation of the depression in the building trades during the greater part of the year. The depression during the first two-thirds of 1915 was of more general effect than in 1914, and the only increase in 1915 was in basalt and related rocks (trap rock) and in limestone, the former chiefly due to increased sales as crushed stone and riprap and the latter caused mainly by a greater demand for furnace flux.

During the closing months of 1915, however, there was a marked increase in building activity, though its effect on the stone industry was not sufficient to offset that of the preceding dull period. The outlook for 1916 is very encouraging. According to L. G. Horowitz, president of the Thompson-Starrett Co.,[1] there are unmistakable signs of at least a partial recovery in the building industry from an extended period of stagnation and depression, which set in well before the beginning of the European war and was aggravated by the outbreak of the war. The recovery is especially noticeable in the Middle West but will be slower in New York City, where, in addition to more general causes, there was an overproduction of buildings when the period of depression was first felt. The change for the better will, in Mr. Horowitz's opinion, be more than the periodic change and more than the ordinary resumption of activity that follows depression.

In a special bulletin of the Chamber of Commerce of the United States of America on "General crop and business conditions," dated December 31, 1915, it is stated that "of the so-called barometers of business there are none so truly indicative of general prosperity as building. It is usually the last industry to feel the impulse of better times, but its activities embrace so many lines of business that its effect is general throughout the country." The editor of Stone,[1] commenting on this and other statements which indicated a general increase in prosperity during the later part of 1915, expresses the belief that the United States "is now at the beginning of a period of prosperity and general business activity that is likely to surpass anything in our history."

[1] Stone, January, 1916, p. 22.

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Granite.—Granite, which represented slightly less than one-fourth of the total value of stone in 1915, decreased $2,296,291, or 11.4 per cent. Granite for monumental work and flagging, which increased slightly in value in 1914, continued to show increase in 1915. Granite for rubble and riprap also increased in 1915, partly offsetting large decrease in 1914. Granite for building, which decreased slightly in 1914, decreased 27 per cent in 1915. Granite for curbing also continued to decrease in 1915, and decrease was shown in 1915 by granite for paving, crushed stone, and other uses.

Basalt and related rocks (trap rock).—Basalt and related rocks showed an increase in value in 1915 of $623,224, or nearly 8 per cent, over the figures for 1914, and offset about half the great decrease in 1914 as compared with 1913. The value of these rocks for all uses except rubble increased in 1915. The most marked increase (64 per cent) was for riprap, which had increased about 10 per cent in 1914. Basalt and related rocks was the only group to show increased sales for crushed stone in 1915.

Marble.—Marble, which increased more than 3 per cent in value in 1914, decreased nearly 15 per cent in 1915. Decrease in 1915 occurred in the value of marble for building and monumental work, as well as for minor uses. Decrease in value of monumental marble in both 1914 and 1915 is contrasted with increase in monumental granite for both of these years

Limestone.—Limestone represented nearly half of the total value of stone for 1915. Its increase, however, of $1,335,711, or nearly 4 per cent, offset only a fraction of the 12.5 per cent decrease in 1914. The principal gain was in limestone for other purposes, mostly flux, which increased $2,204,806 and partly offset a great decrease in 1914. Limestone for building and riprap showed small increase. Crushed limestone, which decreased more than $1,000,000 in value in 1914, decreased by a nearly equal amount in 1915. Other conspicuous losses were in limestone for paving, curbing, and rubble, the value for paving decreasing in both 1914 and 1915. and falling to a value of less than $20,000.

Sandstone.—Sandstone, including bluestone and quartzite, decreased nearly 19 per cent in value in 1915 compared with 1914, and fell to the lowest figure recorded since 1899, when the value was $5,725,395. Sandstone for all uses except rubble decreased in value. About one-third of the total decrease was represented by bluestone, which is discussed on page 824.

PRODUCTION BY USES.

General statistics.—As shown in the table on page 766, the total value of stone for all uses, except riprap and "other uses" decreased in 1915 as compared with 1914.

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Value of stone sold in 1914 and 1915, by kinds and uses.

1914.

Kind.	Building (rough and dressed).	Monumental (rough and dressed).	Paving.	Curbing.	Flagging.	Rubble.	Riprap.	Crushed.	Other.	Total.
Granite	$6,481,091	$4,846,809	$2,831,568	$760,952	$13,849	$322,371	$744,902	$3,975,575	$183,613	$20,160,730
Basalt and related rocks (trap rock)	45,134	.....	112,246	.....	.....	404,600	1,054,947	6,225,805	23,266	7,865,998
Sandstone	1,825,179	.....	713,692	968,317	519,957	105,906	813,460	1,896,505	636,792	7,501,808
Limestone	3,896,854	.....	114,877	120,407	7,134	423,336	1,123,123	18,061,881	10,146,543	33,894,155
Marble	[a] 5,548,294	2,303,484	.....	.....	.....	.....	.....	.....	269,634	8,121,412
	17,796,552	7,150,293	3,772,383	1,869,676	540,940	1,256,213	3,736,432	30,161,766	11,259,848	77,544,103

1915.

Granite	$4,702,627	$4,873,771	$2,349,646	$683,655	$23,197	$502,530	$793,773	$3,823,774	$111,466	$17,864,439
Basalt and related rocks (trap rock)	52,307	.....	146,560	230	.....	128,711	1,732,113	6,397,641	31,660	8,489,222
Sandstone	1,416,842	.....	532,780	890,464	469,777	157,068	362,150	1,849,078	417,621	6,095,800
Limestone	4,056,201	.....	19,396	80,415	7,758	306,116	1,305,636	17,102,995	12,351,349	35,229,866
Marble	[a] 4,864,471	1,873,668	.....	.....	.....	.....	.....	.....	177,886	6,916,025
	15,092,448	6,747,439	3,048,382	1,654,764	500,732	1,094,445	4,193,672	29,173,488	13,089,982	74,595,352
Percentage of decrease or increase in 1915	−17.9	−5.6	−23.8	−11.5	−8.0	−14.8	+12.2	−3.4	+16.3	−3.8

[a] Includes stone for both exterior and interior building.

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The general decrease in value of stone according to uses and the increase in value of certain stones for certain uses are due to the great irregularity of the industry, which, outside of regular quarry centers, is influenced largely by local demand. Construction of sea walls, river improvement work, ballasting of railroad tracks, construction of roads and reservoirs and dams, repairing and construction of locks on canals, and other similar structural work may call for the opening of a quarry and for the abandonment of this quarry as soon as the work is completed. This naturally causes a large increase and a corresponding decrease in the output of those States where there is no regularly defined quarry region, and even in States having regular quarry centers a contract for a large public building or any extra construction work influences the output of the region. In 1915 marked increases, due to such causes and referred to in subsequent pages, were reported from California, New Mexico, New York, Oregon, Vermont, Virginia, and Washington.

Building stone.—Building stone, which had decreased less than 2 per cent in value in 1914, decreased nearly 18 per cent in 1915. According to this comparison, the general depression which began in 1914 and lasted into 1915 did not exert any severe effect upon the building stone industry until the beginning of 1915, as many contracts that were made before the beginning of the dull period were not completed until after the close of 1914. During the first half of 1915, however, very few new contracts were made and many important quarries were either idle or simply doing such development work as would hasten operations when a sufficient demand arose. The building industry, as a whole, began to improve in the fall and was very active at the close of the year, as well as during the first months of 1916.

An improvement may therefore be expected in the marketed production of building stone, but study of the table on page 826 and of figure 26 shows that during the last decade the use of building stone has not kept pace with the general growth of the stone industry. There was a marked increase in use of stone for exterior building from 1900 to 1902, but since then the annual value of sales has generally declined, whereas that of crushed stone for concrete has increased. The only years when both products decreased were in years of general depression—1908, 1914, and the first part of 1915; but in 1913, a prosperous year marked by a substantial increase in crushed stone for concrete, there was a decline of nearly 4 per cent in the value of building stone. This comparison shows the extent to which the use of cheaper artificial materials, made to imitate stone, has injured the building stone industry. As low cost is the principal factor favoring the use of artificial stone, genuine stone at present is restricted in use mainly to the facing of high-class buildings and to trimmings on some of the less pretentious structures.

In recent papers by McMillan [1] and Richter [2] a prime cause of the decline of the building-stone industry was said to be the failure of stone producers and manufacturers of cut stone to see the necessity of cooperating for the benefit of the industry as a whole and of conducting a publicity campaign sufficiently aggressive to offset com-

[1] McMillan, W. M., Address at thirteenth annual convention International Cut Stone Contractors' and Quarrymen's Association (Inc.), of North America, Atlantic City, N. J., 10 pp., Jan. 19, 1916.
[2] Richter, R. M., The future and the stone industry: Stone, vol. 36, pp. 642-646, December, 1915.

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petition with artificial building materials. Another feature has been the tendency of some producers to market only stone of the finest quality, even for mediocre uses, instead of conserving resources and using second or third class stone where the highest degree of appearance is not demanded. Stone rated as second or third class in appearance may be the equal of first-class stone in strength and durability, a statement well supported by the fact that stones now regarded as inferior in appearance have been exposed in buildings of the older cities of the country for as much as 50 or even 100 years without appreciable evidence of deterioration. Exposure for such periods is the most reliable of all tests of building stone. Another fact worth mention here is that the settling of dust and smoke upon the surface of light-colored stone soon obscures its original color so that there is no appreciable difference in appearance between first-class and second-class stone. If more consideration were given to the probable appearance of a building after it is a few years old than to its appearance when it is new, the cost of the stone could probably be lessened without impairing its durability in the least.

Of course examples are numerous where natural stone of poor weathering quality has been used with no regard to its limitations and has given a bad reputation to certain stone, whereas well-selected stock from the same formation or even the same quarry has proved its excellent weathering qualities beyond any doubt. It may be added that some natural stones that are well suited for interior work are quite unfit for exterior use, and that some stone of such character has been wrongly used even in recent years; but experience has shown the qualities that fit or unfit a stone for certain uses, and the better-known building stones now on the market can as a rule be relied upon where durability as well as architectural beauty is a requirement of first importance.

Besides competition with artificial building material, it is also claimed that the stone industry has suffered from recent readjustment of freight rates.[1] Some districts appear to have been more adversely affected than others in this respect.

The building-stone industry has evidently suffered from internal as well as external causes, as competition among producers of building stone is partly responsible for the reduced value of sales in recent years. One type of limestone, according to several producers both of that and of other stones, has been sold in distant markets at a price so low as to win even local trade from sandstones and other limestones of recognized good quality. The price cutting on this stone has gone so far that some producers of it, after operating at a loss for some time, have closed their plants. Notwithstanding these difficulties, limestone was the only important building stone to show increase in total value of sales in 1915.

Monumental stone.—Conditions in the monumental-stone industry were essentially the same in 1915 as in 1914, but the decline in total value was more marked. A decrease of more than 2 per cent in 1914 was followed by one of more than 5½ per cent in 1915, although monumental stone is practically free from competition. In each year there was a small increase in value for monumental granite, but a considerable decrease in value of monumental marble sold. A

[1] McMillan, W. M., op. cit., pp. 1–5.

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small quantity of limestone is also sold for monumental work, and an insignificant quantity of sandstone is also reported as sold locally for tombstone bases.

Monumental stone, more than any other kind, expresses the general financial condition of individuals. Although the more elaborate monuments are erected from public funds or funds of societies, the greater part of monumental stone is sold to individuals. Monumental stone is a luxury and is therefore not used so prevalently at times when the majority of families find it necessary to economize. This fact is illustrated in figure 26 and the table on page 826. The generally improved financial conditions during the first half of 1916 are therefore encouraging to producers of monumental stone.

Paving stone.—Paving stone also decreased in total value in both 1914 (over 4 per cent) and 1915 (nearly 24 per cent). The group of basalt and related rocks was the only one to show increase in 1915, whereas granite was the rock that increased in 1914. This general decrease is in contrast to the increase in value of crushed stone for road metal during the same two years. Although the greater part of this crushed stone was used on country and suburban roads where there was no competition with paving blocks, a considerable quantity was doubtless used with a cement or bituminous binder to repave streets where poorly laid paving blocks were formerly in use. The present specifications of the American Society of Municipal Improvements, for well-laid block pavements, however, insure a smooth surface and one that will give the greatest resistance to wear for the kind of stone used. Block pavements, therefore, may become even more restricted than formerly to the parts of large cities where traffic is heaviest. This applies especially to granite, basalt, and related rocks, and in cities where these rocks can not be easily obtained, to the harder sandstones and siliceous limestones. The relatively small difference in resistance to wear between the average limestone or sandstone blocks and macadam bound with cement or bituminous material renders them more subject to competition with crushed stone. Although no statements from producers of limestone blocks have been received on this subject, the marked decrease of 83 per cent in sales of limestone blocks in 1915 following a decrease of 52 per cent in 1914 may be significant.

Curbing and flagging.—The total value of curbstone in 1915 decreased more than 11 per cent, following a decrease of 10 per cent in 1914. The decrease was general except for a small quantity of basalt and related rocks, none of which were used for curbing in 1914. This general decrease may be due in large part to competition with concrete curbing.

The total value of flagstone also decreased in both 1914 (6 per cent) and 1915 (8 per cent). Granite for flagging, however, increased in value in both years, and limestone showed an increase in 1915. The decrease was in sandstone, especially bluestone, which supplies the bulk of flagging.

The general decrease in value of both curbstone and flagstone is doubtless due in large part to the increasing use of concrete for these purposes, partly because of the lower cost and great adaptability and partly because of the more attractive appearance of concrete compared to natural stone, if it has been carelessly laid or poorly selected.

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There is no question of the ability of well-selected natural stone to resist successfully both weathering and abrasion from traffic, and one producer reports success in the marketing of well-prepared sandstone curbing in competition with artificial curbing. The better grades of bluestone and granite of course are superior to limestone and other sandstone in resistance to wear and are to be recommended where traffic is heavy, but in suburban districts and the smaller communities well-selected limestone and sandstone are quite adequate. Long experience of producers, especially of the better-known stones, enables them to select the best material for curbing and flagging with great accuracy; dressing by machinery now gives true edges and surfaces; and the stone has only to be properly laid to give excellent appearance as well as durability.

Rubble and riprap.—The value of stone for rubble also decreased in both 1914 (21 per cent) and 1915 (nearly 15 per cent). Granite and sandstone for this use, which decreased in 1914, increased in 1915, but not enough to offset decrease in the other kinds of stone.

Stone for riprap increased in value over 12 per cent in 1915, offsetting a nearly equal decrease in 1914. Sandstone was the only kind of stone to show a decrease for this use. The increase in total value of riprap was due principally to basalt used in river and harbor work in Washington and Oregon.

Crushed stone.—Crushed stone, the largest product common to more than one kind of stone, continued to decrease in 1915. In view of the importance of this branch of the stone industry, a special discussion of crushed stone is given on pages 825–842.

Other uses.—Stone for "Other uses," which decreased in value nearly 22 per cent in 1914, increased more than 16 per cent in 1915. "Other uses" included under granite and basalt and related rocks (trap rock), rough stone sold to paving cutters, stone for well covers, chicken grit, and waste stone; under sandstone, ganister valued at $336,267, and small values for tombstone bases, covers, and grit; under marble, material sold as crushed stone, furnace flux, terrazzo, marble dust, etc.; under limestone, furnace flux valued at $9,672,347, stone for sugar factories valued at $381,038, ground stone for agricultural purposes valued at $893,530, and stone for other less important uses whose values are noted in the table on page 818. Both the decrease and the increase in these years were governed by the demand of limestone for furnace flux.

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PRODUCTION BY STATES.

According to the following tables Pennsylvania continued to rank first as a stone-producing State in 1915, its total value increasing more than $1,000,000; but Vermont dropped from second to fourth place, with a decrease of more than $1,000,000. Other conspicuous advances in rank were made by Ohio, from fourth to second place; Indiana from sixth to fifth, regaining its rank of 1913; Virginia from twelfth to ninth, continuing its great rise of 1914; and Michigan from eighteenth to twelfth. The other marked declines in rank were by Georgia, from eleventh to fifteenth place, and Maine, from fourteenth to twenty-third.

Value of stone sold in the United States, 1914 and 1915, by States.

1914.

Rank of State.	State or Territory.	Total value.	Percentage of total.	Number of plants.
1	Pennsylvania	$8,153,413	10.52	622
2	Vermont	6,635,477	8.56	58
3	New York	6,575,079	8.48	218
4	Ohio	5,655,713	7.29	223
5	California	4,610,731	5.95	142
6	Indiana	4,136,132	5.33	117
7	Massachusetts	3,438,556	4.43	135
8	Illinois	2,934,078	3.78	95
9	Wisconsin	2,516,156	3.25	193
10	Missouri	2,294,103	2.96	185
11	Georgia	2,238,789	2.89	37
12	Virginia	2,152,378	2.78	71
13	Tennessee	1,932,462	2.49	64
14	Maine	1,723,082	2.22	52
15	Washington	1,600,615	2.06	27
16	New Jersey	1,533,668	1.98	80
17	Minnesota	1,513,039	1.95	85
18	Michigan	1,500,910	1.94	30
19	North Carolina	1,407,671	1.82	46
20	New Hampshire	1,383,325	1.78	36
21	Colorado	1,322,609	1.71	56
22	Alabama	1,319,753	1.70	38
23	Kentucky	1,257,722	1.62	94
24	Maryland	1,110,506	1.43	61
25	Connecticut	1,063,184	1.37	57
26	West Virginia	921,208	1.19	61
27	Texas	870,224	1.12	46
28	Rhode Island	625,276	.80	19
29	Kansas	600,576	.78	82
30	Iowa	538,681	.70	71
31	Utah	498,319	.64	23
32	Oregon	435,066	.56	29
33	New Mexico	418,305	.54	5
34	Arkansas	360,735	.47	20
35	South Carolina	357,657	.46	11
36	Florida	343,779	.44	14
37	Nebraska	303,680	.39	21
38	Oklahoma	263,673	.34	26
39	Montana	242,080	.31	15
40	South Dakota	156,907	.20	19
41	Delaware	131,086	.17	6
42	Alaska	(a)		
43	Hawaii	88,417	.11	6
44	Arizona	79,341	.10	12
45	Wyoming	62,331	.08	6
46	Idaho	57,909	.08	11
47	Louisiana	(a)		
	Other States	179,252	.23	2
		77,544,103	100.00	3,327

a Included in "Other States."

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Value of stone sold in the United States, 1914 and 1915, by States—Continued.

1915.

Rank of State.	State or Territory.	Total value.	Percentage of total.	Number of plants.
1	Pennsylvania	$9,310,397	12.48	628
2	Ohio	5,816,923	7.80	209
3	New York	5,731,849	7.68	232
4	Vermont	5,620,899	7.54	49
5	Indiana	4,204,192	5.64	109
6	California	3,516,079	4.71	142
7	Massachusetts	3,326,057	4.46	127
8	Illinois	2,907,410	3.90	93
9	Virginia	2,586,427	3.47	78
10	Wisconsin	2,412,741	3.23	187
11	Missouri	2,145,501	2.88	175
12	Michigan	1,943,668	2.61	35
13	Tennessee	1,814,782	2.43	67
14	Washington	1,758,817	2.36	29
15	Georgia	1,720,313	2.31	35
16	New Jersey	1,601,044	2.15	76
17	Minnesota	1,492,341	2.00	89
18	Colorado	1,425,270	1.91	49
19	North Carolina	1,409,963	1.89	42
20	New Hampshire	1,234,149	1.65	34
21	Connecticut	1,134,947	1.52	56
22	Kentucky	1,071,052	1.44	98
23	Maine	1,062,283	1.42	57
24	West Virginia	1,047,695	1.40	71
25	Maryland	916,525	1.23	51
26	Oregon	753,285	1.01	27
27	Texas	726,323	.97	45
28	Alabama	719,452	.96	25
29	Rhode Island	693,950	.93	20
30	Kansas	537,165	.72	68
31	Iowa	536,175	.72	64
32	Oklahoma	430,302	.58	27
33	Florida	354,673	.48	16
34	South Carolina	321,612	.43	19
35	Nebraska	321,341	.43	18
36	New Mexico	308,809	.41	7
37	Utah	288,398	.39	20
38	Montana	263,812	.35	14
39	Arkansas	255,681	.34	19
40	Hawaii	213,122	.29	8
41	South Dakota	159,089	.21	25
42	Alaska	(a)	(a)	2
43	Delaware	131,379	.18	5
44	Arizona	90,512	.12	12
45	Wyoming	70,576	.09	6
46	Louisiana	(a)	(a)	1
47	Idaho	31,228	.04	7
48	District of Columbia	5,775	.01	5
	Other States	171,369	.23	.....
		74,595,352	100.00	3,278

a Included in "Other States."

Of the 48 producing States 23 showed increase in value of sales in 1915, compared with 14 States in 1914. This gain was evenly distributed among the more important States, 11 of the first 24 States showing increase in 1915. Eleven States showed a value of more than $2,000,000 in sales of stone in 1915, compared with 12 in 1914; 13 States show values between $1,000,000 and $2,000,000 in each year.

The total number of active plants in 1915 was 49 less than in 1914. This number has been steadily decreasing in recent years, although the amount of decrease in the dull period of 1914 and in the greater part of 1915 was less than in 1913, when the marketed production of stone reached its record value. The chief causes of this steady decrease are the tendency of small producers to abandon their quarries on account of the lack of demand for foundation stone and the high

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cost and scarcity of labor. The general business depression throughout most of 1914 and 1915 was a temporary cause. Combinations of properties and the regular fluctuations of demand have also had considerable influence on the increase or decrease of operations.

EXPORTS.

The value of exports of stone, which reached a maximum in 1913, decreased steadily in 1914 and 1915, as shown by the following table compiled from statistics furnished by the Bureau of Foreign and Domestic Commerce of the Department of Commerce.

Stone exported from the United States in 1913, 1914, and 1915.

Kind.	1913	1914	1915
Marble and stone, unmanufactured	$606,745	$559,556	$400,510
All others	1,250,147	803,686	635,614
	1,856,892	1,363,242	1,036,124

Comparison of exports to different countries given in the following table shows that the decrease is principally due to the slackened demand from Canada, whose domestic production of stone in 1915 decreased $964,457, or nearly 18 per cent in value. Early in 1915 Canada increased the duty on stone 7½ per cent ad valorem to help defray the expenses of the war. Duty on rough blocks was increased from 15 per cent to 22½ per cent; on stone sawed on two sides from 20 per cent to 27½ per cent. On stone that is planed, turned, or further advanced, the duty is now 45 cents per 100 pounds plus 7½ per cent ad valorem.

Exports to other North American countries also decreased, but those to South American countries, with the exception of Colombia, increased. This increase is interesting in view of the opportunity afforded by the European war for the introduction of stone from the United States to supply the demand formerly filled by European stone.

The absence of exports to Germany and Belgium in 1915 requires no comment, but it is noteworthy that exports to other European countries, except Russia and Sweden, showed marked increase. All exports to countries in Asia, Oceania, and Africa, except New Zealand, increased in 1915.

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Exports of stone (including marble) from the United States in 1914 and 1915.

1914.

Country.	Manufactured.	Unmanufactured.
Europe:		
Belgium	$2,867	$30
Denmark	3,274	.....
France	4,168	.....
Germany	22,651	5
Great Britain	39,356	1,948
Netherlands	4,915	10
Russia	50,108	.....
Sweden	2,485	.....
Other Europe	2,908	.....
	132,732	1,993
North America:		
Canada	448,989	533,113
Newfoundland, etc	1,272	6,246
Mexico	5,118	12,338
Central America	4,499	.....
Panama	23,201	5,486
Cuba	67,311	224
Jamaica	4,471	.....
Barbados	2,467	.....
Trinidad and Tobago Islands	6,954	.....
Other West Indies	4,199	.....
	568,481	557,407
South America:		
Argentina	2,910	.....
Brazil	2,264	.....
Chile	2,926	.....

Country.	Manufactured.	Unmanufactured.
South America—Continued.		
Colombia	$7,277	.....
Other South America	2,580	$156
	17,957	156
Asia:		
China	4,284	.....
British India	9,864	.....
Japan	4,243	.....
Other Asia	806	.....
	19,197	.....
Oceania:		
Australia and Tasmania	44,342	.....
New Zealand	15,962	.....
Philippine Islands	1,773	.....
Other Oceania	265	.....
	62,362	.....
Africa:		
British South Africa	2,504	.....
Other Africa	453	.....
	2,957	.....
Total exports	803,686	559,556
Grand total	1,363,242	

1915.

Country.	Manufactured.	Unmanufactured.
Europe:		
Denmark	$16,026	$827
France	15,941	466
Great Britain	109,819	6,857
Greece	2,407	.....
Italy	6,897	7,943
Netherlands	14,650	.....
Russia	15,712	83
Sweden	1,864	142
Other Europe	3,399	81
	186,724	16,399
North America:		
Canada	194,328	352,202
Newfoundland, Labrador, etc	8,742	6,680
Mexico	5,823	5,418
Central America	3,043	1,370
Panama	7,474	2,989
Cuba	21,293	8,261
Jamaica	3,519	195
Other British West Indies	3,690	321
French West Indies	2,268	41
Other West Indies	2,929	366
	253,109	372,743
South America:		
Argentina	8,563	12
Brazil	6,962	100
Chile	9,564	10
Colombia	4,830	658
Peru	6,441	27

Country.	Manufactured.	Unmanufactured.
South America—Continued.		
Uruguay	$1,500	$310
Venezuela	3,239	12
Other South America	1,517	4
	42,616	1,133
Asia:		
China	10,281	.....
British East Indies	50,316	1,077
Dutch East Indies	4,070	.....
Japan	5,959	434
Other Asia	65	.....
	70,691	1,501
Oceania:		
Australia	47,273	5,951
New Zealand	10,285	634
Philippine Islands	4,057	2,101
Other Oceania	565	.....
	62,180	8,686
Africa:		
British South Africa	17,837	48
Other Africa	2,457	.....
	20,294	48
Total exports	635,614	400,510
Grand total	1,036,124	

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IMPORTS.

The term "general imports" in this publication embraces both imported articles entered for immediate consumption on arrival and articles entered for warehouse, as distinguished from the "imports for consumption," which embrace imports entered for immediate consumption and withdrawals from warehouse for consumption. The statement of general imports and the statement of imports for consumption for any period will differ to the extent that the value of the entries for warehouse for the period differs from the value of the withdrawals from warehouse for consumption. The term "entry for consumption" is the technical name of the import entry made at the customhouse and does not imply that the goods have been actually consumed but simply that they have been delivered into the custody of the importer and that the duties have been paid on the dutiable portion.

As nearly all the imports of stone have come from Europe, where the war has upset industrial conditions, the decrease (nearly 36 per cent) in value in 1915 was to be expected. The imports from 1901 to 1914 showed little variation in value from $1,500,000, but in 1915 they dropped below $900,000, as shown in the following table compiled from statistics furnished by the Bureau of Foreign and Domestic Commerce of the Department of Commerce:

Stone imported for consumption in the United States in 1914 and 1915.

Kind.	1914		1915	
	Quantity.	Value.	Quantity.	Value.
Marble:				
In block, rough, etc.....cubic feet..	567,306	$378,284	334,279	$488,157
Sawed or dressed.....do....	.....	.....	76	61
Slabs or paving tiles.....sup. feet..	279,028	62,828	95,778	18,388
All other manufactures.....	.....	153,920	.....	87,429
Mosaic cubes:				
Loose.....pounds..	.....	30,566	.....	13,607
Attached to paper.....do....	.....	1,541	.....	19
	.....	1,127,139	.....	607,751
Onyx:				
In blocks, rough, etc.....cubic feet..	10,693	31,368	5,944	30,184
All other manufactures.....	.....	2,026	.....	522
	.....	33,394	.....	30,706
Granite:				
Dressed.....	.....	155,777	.....	134,720
Rough.....cubic feet..	5,788	2,280	18,956	9,662
	.....	158,057	.....	144,382
Stone (other):				
Dressed.....	.....	15,994	.....	14,254
Rough (monumental or building stone)..cubic feet..	43,753	25,978	8,375	41,557
Rough (other).....	.....	28,911	.....	54,018
	.....	70,883	.....	109,829
Grand total.....	.....	1,389,473	.....	892,668

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Marble imports, principally rough blocks, decreased nearly one-half in value. The only European country from which imports in 1915 approximated those of 1914 was Greece, as shown in the table below. In the Carrara district of Italy the war and the consequent unsettled state of business during the last half of 1914 caused a steady decline in production, until at the end of that year only one-fifth of the normal quantity of stone was being quarried. The fact that the United States takes one-sixth of the total exports of Carrara marble and that North America and South America together buy about one-third tended to prevent a total cessation of work at the quarries.[1]

Total imports of onyx marble in 1915 decreased nearly $2,700 in value, a little less than the decrease in 1914. Imports from Mexico, which include by far the greater part of total imports of onyx marble, increased about $4,000 in value. Mexican onyx marble probably comes mostly or wholly from Lower California, outside the area of marked political disturbance.

General imports of marble and onyx, rough and manufactured into the United States in 1914 and 1915.

1914.

Country.	Value.	Country.	Value.
Austria-Hungary	$1,153	Canada	$976
Belgium	26,351	Mexico	29,122
Denmark	5,515		
France	45,974	Total North America	30,098
Germany	12,023		
Greece	22,163	Other countries	1,502
Italy	1,006,008		
Great Britain	13,968	Grand total	1,166,111
Other Europe	1,356		
Total Europe	1,134,511		

1915.

Austria-Hungary	$5	Canada	$283
Belgium	3,843	Mexico	33,129
France	31,050	Cuba	24
Germany	728		
Greece	20,607	Total North America	33,736
Italy	553,367		
Great Britain and Ireland	4,012	Other countries	235
Other Europe	260		
		Grand total	647,943
Total Europe	613,872		

Imports of granite in 1915 decreased $13,675, or nearly 9 per cent, in value, as compared with 1914, but the value in 1915 was considerably above that in 1913 ($115,525).

Imports of stone other than marble and granite showed a substantial increase in value in 1915, compared with 1914, and also exceeded the value for 1913 ($95,699).

[1] Wilber, D. F., Italy: Supplement to Commerce Repts., Dept. Commerce, Bur. Foreign and Domestic Commerce Ann. Ser. 8c, p. 21, Dec. 18, 1915.

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The following paragraph, quoted from Stone,[1] is of interest in connection with imports of granite.

A royal proclamation has been issued in Great Britain prohibiting the import into that country after March 1, except under Board of Trade license, of a large number of articles, including stones and slates. The Aberdeen granite merchants are seriously concerned over the embargo on the importations of Swedish granite. The British legation at Stockholm has notified ship owners that return cargoes of coal and other necessaries to Sweden will be given only in exchange for pit props and iron ore. Inasmuch as a considerable part of the Aberdeen granite trade is working of Swedish granite, much of which is exported to America, the manufacturers have made strong representations to the Government, but without avail as yet. The trade was hard hit by the war, even without this new regulation.

At a meeting of the Quarrymen's Union at Enderby, England, it was stated that the war had caused a terrible slump in the curb and paving block trade. In Wales alone over 500 block makers had recently been discharged.

GRANITE.

MARKETED PRODUCTION.

General statistics.—The figures here given as representing the value of the granite produced and sold in the United States include the value of small quantities of other crystalline and igneous rocks, such as syenite, gneiss, schist, tuff, rhyolite, trachyte, and andesite. The quantities of these rocks quarried are too small to tabulate separately, and the production of the igneous rocks other than granite could not be given for certain States because there are less than three producers reporting. The quarrying of basalt and related rocks, commonly called "trap rock," in Arkansas, California, Connecticut, Hawaii, Massachusetts, northern Michigan, Minnesota, New Jersey, New York, Oregon, Pennsylvania, and Washington represents, however, an industry sufficient by itself to make it practicable to tabulate this stone separately, and therefore its value is not included in the grand total of granite.

The value of granite produced and sold in the United States in 1915, as shown in the accompanying table, was $2,296,291, or 11.4 per cent, less than in 1914 and was lower than in any year since 1905, when the value was $17,563,139. The seven leading States, having marketed production valued at more than $1,000,000 in 1915, were in order of rank, Vermont, Massachusetts, California, Wisconsin, North Carolina, New Hampshire, and Maine. The order in 1914 was Vermont, California, Massachusetts, Maine, New Hampshire, Wisconsin, and North Carolina. All these States showed decrease in 1915. The value of Vermont's output fell below $3,000,000 for the first time since 1911, and extraordinarily large decrease was shown by both California and Maine. Conditions in Vermont and California were largely due to strikes, that at Barre and vicinity in Vermont lasting 11 weeks and that at San Francisco and elsewhere in California lasting 5½ months. North Carolina's prominence in recent years is attributed in part to a marked demand for mausoleum work and to the fact that climatic conditions allow continuous operation of finishing plants throughout the year.

[1] Stone, March, 1916, pp. 147–148.

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Value of granite sold in the United States, 1911–1915.

State or Territory.	1911	1912	1913	1914	1915
Alabama	(a)				
Arizona	$13,105	$26,501	$13,270	$37,831	$71,087
Arkansas	b 354,041	b 366,354	b 378,110		(a)
California	1,738,094	1,583,583	1,451,149	2,386,579	1,656,706
Colorado	137,356	55,010	84,497	74,774	65,876
Connecticut	574,673	761,757	765,334	405,655	318,909
Delaware	218,234	193,074	289,987	131,066	131,379
District of Columbia	(a)				5,775
Georgia	847,023	823,207	906,470	958,831	660,454
Idaho	(a)	30,300	113,710	(a)	(a)
Maine	2,257,034	1,803,679	1,790,279	1,717,110	1,062,283
Maryland	845,936	749,555	806,259	846,838	662,466
Massachusetts	2,361,624	2,220,279	2,220,630	2,091,417	2,071,203
Minnesota	797,244	950,033	853,111	735,753	841,943
Missouri	139,070	97,776	42,484	77,971	85,625
Montana	29,670	28,666	31,520	25,977	28,839
Nevada	(a)	(a)			
New Hampshire	1,017,272	1,311,488	1,482,771	1,383,325	1,234,149
New Jersey	167,112	142,515	62,637	74,808	95,986
New Mexico	(a)	(a)	(a)	(a)	
New York	344,038	431,910	746,826	797,297	747,242
North Carolina	772,685	983,615	1,116,475	1,286,345	1,246,810
Oklahoma	20,244	14,460	30,678	24,695	29,141
Oregon	b 580,978	16,721	37,807	36,852	7,246
Pennsylvania	491,428	575,680	1,102,206	511,013	506,380
Rhode Island	957,743	767,507	642,375	621,620	691,765
South Carolina	335,617	263,905	360,476	357,657	319,080
South Dakota	(a)	(a)	(a)	(a)	22,379
Texas	70,488	67,613	76,067	115,857	86,968
Utah	5,209	8,975	(a)	(a)	(a)
Vermont	2,730,719	3,047,954	3,782,235	3,120,452	2,778,730
Virginia	420,611	470,657	462,162	805,287	869,284
Washington	b 1,345,551	140,581	140,279	72,079	260,686
Wisconsin	1,382,309	1,179,018	927,616	1,341,455	1,256,851
Other States	239,120	110,929	15,797	122,166	49,175
	21,194,228	19,223,302	20,733,217	20,160,730	17,864,439

a Included in "Other States".

b Includes basalt or trap rock.

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Value of granite sold in the United States in 1914 and 1915.

1914.

State.	Sold in the rough.					Dressed for—		Made into paving blocks.
	Building.	Monumental.	Rubble.	Riprap.	Other.	Building.	Monumental.	
Arizona	$3,130	$3,250	.....	$29,090	.....	.....	$1,000	.....
California	149,599	60,809	$2,724	351,619	$1,229	$878,375	45,227	$106,516
Colorado	3,910	51,969	345	1,250	.....	100	.....	.....
Connecticut	25,124	30,948	59,170	89,584	1,310	84,279	30,661	43,174
Delaware	1,702	.....	10,814	27,433	.....	1,146	.....	4,690
Georgia	23,982	14,261	42,107	.....	4,550	250,843	20,252	221,563
Idaho[a]	.....	.....	.....	.....	.....	.....	.....	.....
Maine	144,407	61,611	38,718	10,167	8,587	794,313	25,697	529,853
Maryland	119,606	9,781	12,877	3,934	88	11,530	8,825	24,394
Massachusetts	46,321	451,095	64,809	19,708	10,967	710,171	34,750	418,671
Minnesota	2,537	115,809	5,078	1,780	.....	60,092	436,793	86,441
Missouri	1,737	24,172	.....	1,541	.....	6,750	.....	26,323
Montana	1,240	11,960	.....	.....	.....	8,895	.....	.....
New Hampshire	84,680	93,466	3,857	1,787	703	491,483	211,503	391,480
New Jersey	1,600	2,000	948	2,243	600	.....	.....	.....
New Mexico[a]	.....	.....	.....	.....	.....	.....	.....	.....
New York	127,495	10,059	5,000	66,636	100	221,413	8,133	10,909
North Carolina	68,417	4,681	11,675	1,012	100	375,925	34,710	243,314
Oklahoma	.....	9,440	1,900	.....	.....	2,145	9,610	.....
Oregon	24	1,727	.....	.....	.....	100	8,775	.....
Pennsylvania	192,428	8,474	10,309	3,958	55,615	41,288	42,000	77,018
Rhode Island	8,931	186,388	145	.....	253	11,905	246,209	51,298
South Carolina	1,138	73,113	5,564	17,563	194	1,697	85,000	2,082
South Dakota[a]	.....	.....	.....	.....	.....	.....	.....	.....
Texas	11,540	37,861	.....	24,962	1,920	.....	18,100	.....
Utah[a]	.....	.....	.....	.....	.....	.....	.....	.....
Vermont	15,705	1,509,795	1,169	.....	12,683	1,321,534	242,227	3,375
Virginia	57,400	8,894	44,689	59,700	.....	5,187	6,500	41,750
Washington	953	2,049	.....	25,921	1,800	13,252	8,177	617
Wisconsin	2,352	36,931	473	54	17,030	1,038	483,843	548,100
Other States	91,280	660	.....	4,960	.....	392	17,614	.....
	1,187,238	2,821,203	322,371	744,902	117,729	5,293,853	2,025,606	2,831,565

State.	Curbing.	Flagging.	Crushed stone.			Other.	Total.
			Road metal.	Railroad ballast.	Concrete.		
Arizona	.....	.....	.....	.....	$1,361	.....	$37,831
California	$59,889	$164	$316,807	$117,376	295,124	$1,121	2,386,579
Colorado	.....	.....	8,600	.....	8,600	.....	74,774
Connecticut	26,142	100	4,401	.....	2,550	8,212	405,655
Delaware	4,652	84	33,501	5,950	40,932	182	131,086
Georgia	226,739	.....	2,888	35,039	110,330	6,277	958,831
Idaho	.....	.....	.....	.....	.....	.....	(a)
Maine	80,011	2,060	4,650	6,667	9,781	588	1,717,110
Maryland	3,000	.....	231,149	165,312	249,436	6,906	846,838
Massachusetts	141,508	2,578	114,905	2,325	59,301	14,308	2,091,417
Minnesota	3,619	.....	19,854	.....	3,750	.....	735,753
Missouri	2,500	.....	.....	.....	8,546	6,402	77,971
Montana	.....	.....	.....	.....	3,882	.....	25,977
New Hampshire	74,474	100	13,745	.....	4,266	11,781	1,383,325
New Jersey	.....	.....	18,465	31,109	17,843	.....	74,808
New Mexico	.....	.....	.....	.....	.....	.....	(a)
New York	4,502	.....	12,525	.....	330,450	75	797,297
North Carolina	86,986	300	56,443	89,515	308,884	4,333	1,286,345
Oklahoma	.....	1,500	.....	.....	.....	100	24,695
Oregon	.....	.....	.....	.....	22,000	4,226	36,852
Pennsylvania	1,709	5,563	28,874	350	43,427	.....	511,013
Rhode Island	15,350	.....	72,123	.....	20,013	.....	621,620
South Carolina	8,021	.....	27,684	58,019	77,354	228	357,657
South Dakota	.....	.....	.....	.....	.....	.....	(a)
Texas	1,474	.....	12,320	350	7,330	.....	115,857
Utah	.....	.....	.....	.....	.....	.....	(a)
Vermont	1,135	.....	3,953	.....	8,876	5	3,120,457
Virginia	10,753	.....	471,902	30,354	68,153	.....	805,282
Washington	8,488	.....	7,532	.....	2,200	1,090	72,079
Wisconsin	.....	1,400	105,048	.....	145,186	.....	1,341,455
Other States	.....	.....	.....	7,260	.....	.....	122,166
	760,952	13,849	1,567,374	549,626	1,858,575	65,884	20,160,730

[a] Included in "Other States."

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Value of granite sold in the United States in 1914 and 1915—Continued.

1915.

State.	Sold in the rough.					Dressed for—		Made into paving blocks.
	Building.	Monumental.	Rubble.	Riprap.	Other.	Building.	Monumental.	
Arizona	$3,000	$800	.....	$54,914	.....	$200	$5,000	.....
Arkansas [a]	.....	.....	.....	.....	.....	.....	.....	.....
California	24,898	32,701	$48,644	362,369	$3,767	231,744	43,705	$42,465
Colorado	2,465	42,114	384	.....	204	.....	5,760	.....
Connecticut	62,636	41,082	1,956	24,555	2,766	95,938	40,282	21,899
Delaware	8,196	173	22,007	38,064	.....	108	.....	721
District of Columbia	.....	.....	5,775	.....	.....	.....	.....	.....
Georgia	8,396	31,171	16,191	.....	1,420	88,183	106,268	108,177
Idaho [a]	.....	.....	.....	.....	.....	.....	.....	.....
Maine	90,220	58,762	5,397	9,561	842	265,992	38,054	495,327
Maryland	45,796	17,500	1,765	3,922	.....	18,278	9,441	29,732
Massachusetts	168,264	419,900	23,011	17,002	44,993	768,957	12,689	283,612
Minnesota	2,560	68,558	3,714	2,295	3,608	117,017	504,611	123,940
Missouri	3,596	27,357	138	674	.....	.....	.....	42,498
Montana	.....	2,484	.....	.....	.....	25,545	800	.....
New Hampshire	69,089	62,349	2,895	9,443	1,472	549,702	218,873	205,456
New Jersey	208	900	1,050	1,971	.....	.....	.....	.....
New York	14,946	294,188	111,549	130,995	.....	17,987	15,335	70,960
North Carolina	30,865	9,660	49,387	54,039	2,000	366,536	10,660	191,796
Oklahoma	1,600	9,326	1,700	.....	500	400	13,940	.....
Oregon	.....	1,538	.....	.....	.....	.....	3,400	.....
Pennsylvania	201,739	13,586	27,862	12,840	707	32,907	57,202	65,560
Rhode Island	24,830	211,840	3	1,824	468	60,552	98,176	58,721
South Carolina	5,342	56,000	26,187	4,685	400	3,150	20,000	.....
South Dakota	.....	.....	.....	.....	.....	650	16,300	.....
Texas	8,200	35,600	.....	4,738	300	1,000	36,000	.....
Utah [a]	.....	.....	.....	.....	.....	.....	.....	.....
Vermont	11,394	1,334,427	.....	1,951	7,280	1,088,950	322,268	1,430
Virginia	32,561	8,738	26,862	57,407	.....	810	10,528	26,531
Washington	4,214	4,934	125,208	230	.....	86,446	6,708	3,078
Wisconsin	995	17,850	760	294	120	8,167	473,293	577,758
Other States	47,400	840	85	.....	.....	.....	100	.....
	873,408	2,804,378	502,530	793,773	70,847	3,829,219	2,069,393	2,349,646

State.	Curbing.	Flagging.	Crushed stone.			Other.	Total.
			Road metal.	Railroad ballast.	Concrete.		
Arizona	.....	.....	.....	$7,173	.....	.....	$71,087
Arkansas	.....	.....	.....	.....	.....	.....	(a)
California	$55,598	.....	$337,964	179,582	$292,902	$360	1,656,706
Colorado	.....	.....	2,778	.....	12,171	.....	65,876
Connecticut	23,633	$120	1,299	.....	2,393	350	318,909
Delaware	3,337	.....	21,707	11,770	25,296	.....	131,379
District of Columbia	.....	.....	.....	.....	.....	.....	5,775
Georgia	155,896	.....	31,696	26,136	79,383	7,537	660,454
Idaho	.....	.....	.....	.....	.....	.....	(a)
Maine	85,171	2,830	1,409	2,349	4,123	2,246	1,062,283
Maryland	210	6,000	193,079	209,532	126,218	993	662,466
Massachusetts	133,823	3,100	103,032	1,402	87,549	3,869	2,071,283
Minnesota	100	.....	15,540	.....	.....	.....	841,943
Missouri	684	.....	4,936	.....	5,287	460	86,635
Montana	.....	.....	.....	.....	.....	.....	28,829
New Hampshire	77,644	.....	12,416	.....	11,001	13,809	1,234,169
New Jersey	.....	.....	51,260	38,097	2,500	.....	95,986
New York	1,166	.....	21,246	5	68,875	.....	747,242
North Carolina	89,222	.....	61,796	78,765	302,084	.....	1,246,810
Oklahoma	.....	1,500	75	.....	.....	100	29,141
Oregon	.....	.....	.....	.....	.....	2,308	7,246
Pennsylvania	3,386	6,128	32,641	100	50,259	1,443	506,300
Rhode Island	15,819	.....	109,802	.....	109,730	.....	691,765
South Carolina	9,925	.....	26,566	49,678	117,070	27	319,030
South Dakota	.....	.....	2,535	.....	2,894	.....	22,379
Texas	130	.....	.....	.....	1,000	.....	86,968
Utah	.....	.....	.....	.....	.....	.....	(a)
Vermont	1,727	.....	2,804	125	5,874	500	2,778,739
Virginia	13,668	60	537,691	88,532	61,046	4,950	899,384
Washington	10,880	.....	18,082	.....	.....	908	260,088
Wisconsin	1,636	3,459	73,864	.....	97,905	750	1,256,881
Other States	.....	.....	.....	750	.....	.....	49,175
	683,655	23,197	1,664,218	693,996	1,465,560	40,619	17,854,429

[a] Included in "Other States."

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Of the 34 granite-producing States 14 showed increase in value of sales in 1915, but only 5 of them showed values in excess of $100,000. Of these 5, according to the table on page 780, Delaware's slight increase was mainly due to rubble and riprap; Minnesota's increase of more than $100,000 was due to dressed building and monumental stone and to paving blocks; Rhode Island's was mainly due to crushed stone, which, with smaller increases in building and rough monumental stone, more than offset a large decrease in dressed monumental stone; Virginia's increase was due almost wholly to crushed stone, which overshadowed decreases in most other uses; Washington's increase of nearly $190,000 was due mainly to rubble and dressed building stone and in part to rough building and monumental stone and to crushed stone.

Building stone.—About 26 per cent of the value of granite produced and sold in 1915 was represented by building stone. This was valued at $4,702,627, of which less than one-fifth was the value of rough stone. Compared with the corresponding value, $6,481,091, in 1914, this was a decrease of $1,778,464, or more than 27 per cent. More than 23 per cent of this amount was represented by Vermont granite in 1915, compared with about 21 per cent in 1914 and 30 per cent in 1913. Other leading States in 1915 and their percentage of the total value were: Massachusetts, 20 per cent; New Hampshire, 13 per cent; North Carolina, 8 per cent; Maine, 7.5 per cent; California, 5 per cent; and Pennsylvania, 5 per cent. Comparison of the values of total building stone for the leading States in 1915 with those of 1914 shows marked decrease for California, Maine, North Carolina, and Vermont, and increase for Massachusetts and New Hampshire. Pennsylvania, as usual, contributed more rough stone than any other State, and Massachusetts was second.

The principal conditions to which producers attributed the decreased production of granite in 1915 were the general financial depression, which affected the building industry during the greater part of the year, and the strikes, already mentioned, in certain important districts. It is further stated that, although building in general increased in the later part of 1915, it had not improved appreciably with respect to the better types of commercial and public buildings, for which granite is likely to be used. One producer stated that there was probably only one contract let in the United States in 1915 that called for granite valued in excess of $200,000.

The opinion has also been expressed that the order issued by the Secretary of the Treasury, June 29, 1915, regulating the use of stone in Government buildings is likely to affect the granite industry unfavorably. According to this order, buildings of Class A, including post offices of the first class with annual receipts of $800,000, are to be faced with granite or marble, interior finish to include the finest grades of bronze, mahogany, etc.; buildings of Class B, including post offices of the first class with annual receipts from $60,000 to $800,000, are to be faced with limestone or sandstone, interior finish to exclude the most expensive woods and marbles; buildings of Class C, including post offices of the second class with receipts of $15,000, and of the first class with receipts up to $60,000, are to be faced with brick trimmed with stone or terra cotta, interior to exclude the more expensive woods or marbles, and marble to be used only where sanitary conditions demand; buildings of Class D,

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including post offices with receipts less than $15,000, to be faced with brick and to include only little stone or terra cotta.

No reference is made in the above statement regarding the use of granite in buildings outside of Class A for base courses, steps, water tables, and approaches of the building, where the superior wearing and weathering qualities of granite naturally give it preference over other kinds of stone. It has been feared by some that the new regulation would completely exclude granite from all except the relatively few buildings of Class A, but the writer is informed that granite will continue to be used as formerly for the special parts referred to in buildings of other classes.

Monumental stone.—Monumental granite (rough and dressed) represented 27 per cent of the total value of granite in 1915, amounting to $4,873,771, an increase of $26,962, or nearly 0.6 per cent, compared with an increase of nearly 3 per cent in 1914. In both years about three-fifths of the total value was for rough stone, rough stone decreasing slightly and dressed stone increasing slightly in 1915. Vermont's total, mainly rough stone, was 34 per cent of the total monumental stone in 1915, compared with 36 per cent in 1914. The other more important States with their percentage of the total value were: Minnesota (12 per cent), Wisconsin (10 per cent), and Massachusetts (9 per cent).

The general increase in value of monumental granite, though small, is encouraging in view of depressed conditions in the stone trade. Vermont's decrease of only 5 per cent in spite of the 11 weeks of idleness due to the strike is noteworthy. Massachusetts showed a decrease of nearly 11 per cent and Wisconsin of nearly 6 per cent, but Minnesota showed an increase in spite of the fact that some producers reported conditions to be poorer than in 1914, owing to the general unsettled conditions and also to poor conditions in the agricultural districts of Iowa and Nebraska, where considerable Minnesota granite is sold for monumental work. The outlook for 1916 is encouraging.

Rubble and riprap.—The large increase in value of granite for rubble and the smaller increase for riprap in 1915 are in contrast to decrease for both products in 1914. The principal gains in rubble were by the States of Washington and New York, both of which showed values of more than $110,000 in 1915, whereas Washington showed no sales and New York a value of only $5,000 in 1914. Other important gains were made by Connecticut, California, North Carolina, and South Carolina, and largely offset decreases of similar magnitude in several of the Atlantic Coast States. Washington's large increase was due to a large quantity of stone from Thurston County used in rubble and jetty construction. New York's increase in rubble and also in riprap, as well as in crushed stone, was due to stone quarried directly for masonry and concrete work in construction of dams, a considerable quantity of which was from excavations in New York City.

The leading States in riprap were California and New York, both showing gains in 1915. North Carolina and Arizona also showed considerable gains. California's large value was due to continuation of harbor improvement work; Arizona's to construction of a reservoir near Yuma; and North Carolina's to stone quarried in Wilson County for jetty work.

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Paving blocks.—Paving blocks represented 13 per cent of the total value of granite sold in 1915, compared to 14 per cent in 1914. Granite paving blocks, like building stone, underwent a great decline in quantity and value in 1915—a decline of nearly 16 per cent in quantity and of 17 per cent in value. Both quantity and value of granite paving blocks sold in 1915 were less than in any year since 1907, which marked the middle point of markedly large annual increases. This increase continued until 1909, when the value exceeded $2,800,000. Successive decreases followed until 1912, when the value had dropped to nearly $2,560,000, and increases were recorded in 1913 and 1914, the latter passing all previous records.

The five leading States in value, Wisconsin, Maine, Massachusetts, New Hampshire, and North Carolina retained the same rank in 1915 as in 1914, and Maine continued to rank first in quantity; but all except Wisconsin showed large decrease in 1915. The only other States to show considerable increase were New York, Minnesota, and Missouri. Increase in the three interior States indicates a better demand especially in Chicago, St. Louis, and other large interior cities, but this increase, as well as that in New York, offsets only a small fraction of the general decrease in Eastern States and California. Strikes may have interfered with production in California and South Carolina, although one South Carolina producer reported increased production in spite of the strike; but the decrease in the Eastern States, which supply blocks for Boston, New York, Philadelphia, Baltimore, and other large eastern and southern as well as some central cities, was evidently due to the general depression which affected the stone industry during the greater part of 1915.

The accompanying table gives the quantity and value of paving blocks quarried and sold by the quarrymen. In some States, notably Vermont, a considerable quantity of stone is sold to manufacturers who manufacture the paving blocks and market them. As these firms have no connection with the quarries and as the stones purchased by them is already reported by the quarrymen as sold rough, the blocks manufactured are not included in the figures of the paving-block industry. This output in Vermont was about 2,000,000 blocks, valued at about $70,000, in 1914 and about 800,000 blocks, valued at about $24,000, in 1915. In Massachusetts the quarrymen themselves sell the paving blocks manufactured by the "motion" men, who manufacture the blocks from their stone, and these blocks are included in the total. The value of granite paving blocks varies with size and amount of dressing from about $25 to $100 a thousand.

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Granite paving blocks sold in 1914 and 1915.

State.	1914.		1915	
	Number.	Value.	Number.	Value.
California	1,904,153	$186,516	999,980	$42,465
Connecticut	990,022	43,174	445,466	21,389
Delaware	118,143	4,690	16,760	721
Georgia	5,986,834	221,563	3,689,970	108,177
Maine	10,708,177	539,853	10,910,032	495,337
Maryland	389,460	24,394	560,101	29,733
Massachusetts	8,326,520	418,671	5,580,441	283,612
Minnesota	1,123,750	86,441	1,859,715	123,940
Missouri	587,220	26,323	930,000	42,493
New Hampshire	9,449,108	391,480	4,243,753	205,486
New York	218,184	10,909	1,956,660	70,959
North Carolina	4,473,259	243,314	4,024,677	191,796
Pennsylvania	1,571,760	77,018	1,271,169	65,889
Rhode Island	901,843	51,296	832,243	58,721
South Carolina	83,884	2,082		
Vermont	75,000	3,375	34,860	1,430
Virginia	909,000	41,750	626,213	26,531
Washington	10,280	617	22,360	3,078
Wisconsin	9,351,707	548,100	10,239,714	577,738
	57,077,174	2,831,566	48,101,484	2,349,666
Average price per thousand		$49.60		$48.85
Percentage of decrease in 1915 as compared with 1914			15.7	17.6

Curbing and flagging.—The value of granite for curbing decreased $83,919 in 1913, $53,338 in 1914, and $77,297 in 1915. In 1915 10 States showed increase and 10 decrease, but the decrease of the leading State alone, Georgia, was more than three times the total increase. As increase and decrease took place in adjacent States, sales of granite curbing were evidently affected by local rather than general conditions.

Granite for flagging represents so small a fraction of the total value of granite that its increase of 67 per cent in 1915, following one of 5 per cent in 1914, is not of much significance. The increase in 1915 was largely accounted for by sales in Maryland which yielded no granite flagging in 1914. Wisconsin, Maine, and Massachusetts also showed increase.

Crushed stone.—Crushed granite represented over 21 per cent of the total value of granite in 1915, compared with 20 per cent in 1914, although its value in 1915 decreased $151,801. Decrease in crushed granite for concrete more than offset increase for road metal and railroad ballast.

GRANITE IN INDIVIDUAL STATES.

GENERAL STATEMENT.

It is always recognized that statistics are of much greater service when both the quantity and the value are given, and the Survey has endeavored to render the stone statistics as complete as possible by publishing such figures of quantity as can be compiled from the data reported by the quarrymen. Owing to the various units of measurement used and to the lack of uniformity of some of the units and also because many operators give no unit it is difficult to compile figures of quantity. However, the majority of producers in several

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of the larger granite States report fairly conformable figures of quantity, and below is given the output of Maine, Minnesota, New Hampshire, Vermont, and Wisconsin, showing the quantity and the distribution of the output by counties. No county figures are published unless there are three or more producers in the county. As requests have been made for the output of Massachusetts according to the distribution of the output, the figures of value are given by counties as far as they can be made available. It is to be regretted that the quantities for this State can not also be published.

MAINE.

From one-third to one-half of the granite quarried in Maine is for building stone, much of it in large blocks for cyclopean masonry. Owing to the proximity of many of the quarries to tidewater and to the smaller number of pieces to handle, the stone sells at a lower price than the granite of several other States. For the same reasons and because there is usually so little carving on the larger blocks, dressed building stone and monumental stone bring as a rule a comparatively low price.

The total value of granite sold in Maine in 1915, shown in the table on page 786, declined $654,827, the decline being principally in building stone and in minor part in paving blocks and crushed stone. This marked decline followed a decline of $73,169 in 1914 and one of $13,400 in 1913.

The great decrease in both quantity (442,427 cubic feet) and value ($582,508) of Maine granite for building in 1915 reflects the general lack of demand cited in the general discussion above. No local causes for the decrease of building stone or any other class of granite have been reported. There was a small net increase in average price, in contrast to decrease in both 1914 and 1913.

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Granite sold in Maine in 1914 and 1915.

1914.

County.	Number of operators.	Building.				Monumental.				Paving.		Crushed stone.		Curbing and flagging.		Other.	Total value
		Rough.		Dressed.		Rough.		Dressed.									
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (number of blocks).	Value.	Quantity (short tons).	Value.	Quantity (linear feet).	Value.	Value.	
Cumberland, Franklin, Oxford, Somerset, and York	11	79,300	$14,717	111,009	$281,418	17,998	$6,349	2,720	$3,184	448,012	$21,445	27,900	$20,618	12,309	$3,673	$3,014	$354,418
Hancock	24	411,779	128,190	192,782	212,723	67,963	20,982	8,100	8,200	1,284,040	58,284	.....	.....	171,040	78,398	24,621	531,398
Kennebec, Knox, and Waldo	7	.....	.....	152,577	298,572	40,021	19,056	3,189	8,151	8,973,016	449,987	.....	.....	.....	.....	30,425	806,191
Washington and Aroostook	8	4,500	1,500	480	1,600	15,500	15,224	2,875	6,162	3,115	137	600	480	.....	.....	.....	25,103
	50	495,579	144,407	456,848	794,313	141,482	61,611	16,884	25,697	10,708,177	529,853	28,500	21,098	183,349	82,071	58,060	1,717,110
Average price	.....	.....	$0.29	.....	$1.74	.....	$0.44	.....	$1.52	Per M, $49.48		.....	$0.74	.....	$0.45	.....	.....

1915.

Cumberland, Franklin, Somerset, and York	14	43,281	$8,066	36,585	$133,105	15,642	$8,914	3,170	$3,060	657,380	$27,999	10,530	$7,881	19,771	$5,225	$1,097	$195,247
Hancock	23	318,675	80,528	61,893	48,250	20,000	9,600	4,172	10,008	1,101,838	51,099	.....	.....	164,290	81,775	11,406	292,666
Kennebec, Knox, and Waldo	12	3,199	1,251	41,531	84,412	43,732	23,652	5,624	15,325	9,150,814	416,329	.....	.....	2,025	1,001	5,403	547,373
Washington and Aroostook	8	4,800	375	36	225	17,297	16,596	3,380	9,661	.....	.....	.....	.....	.....	.....	140	26,997
	57	369,955	90,220	140,045	265,992	96,671	58,762	16,346	38,054	10,910,032	495,327	10,530	7,881	186,086	88,001	18,046	1,062,283
Average price	.....	.....	$0.24	.....	$1.90	.....	$0.60	.....	$2.33	Per M, $45.40		.....	$0.75	.....	$0.47	.....	.....

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Monumental granite decreased in quantity but increased in value for both rough and dressed stone. The average price of both also increased, although monumental granite forms only a small part of Maine's total production. These increases following increases in quantity and value, as well as in average price of dressed stone, in 1914, give reason for encouragement.

Paving blocks, which showed a larger decrease in value in 1914 than any other kind of granite, decreased further in 1915, in spite of an increase in quantity of more than 200,000 blocks. The price per thousand, which decreased $3.46 in 1914, decreased $4.08 more in 1915.

Crushed stone, supplying a small demand, shows fluctuations in sales from year to year. Decrease in quantity and value was followed by increase in 1914 and by decrease in 1915. The average price per ton, which decreased 11 cents in 1914, increased 1 cent in 1915.

Curbing and flagging, which had decreased in quantity, value, and average price, in both 1913 and 1914, showed a small increase in all three respects in 1915.

Granite for "other uses" showed a marked decrease in value, the largest decrease except that of building stone.

MASSACHUSETTS.

It is still impossible to show the quantity of granite quarried in Massachusetts. The following table of values, however, serves to show the distribution of granite quarried for different uses. Massachusetts, like Maine, showed decrease in total value in 1914 and 1915, but the decrease in 1915 ($20,214) was much smaller than that of 1914 ($129,213).

Building stone in Massachusetts was an exception to the rule for 1915 in the Eastern States, showing a gain in value of $180,729, or nearly 24 per cent. This was the result in part of a demand for higher priced stone from Essex County, which increased the value in spite of a locally decreased tonnage. The value of dressed stone from Worcester County also added materially to the increase.

Decrease in value of monumental stone was due to absence of sales of rough stone from Essex County and to decreased demand for dressed stone from Middlesex and Norfolk counties.

Decrease in value of paving and "other" stone and increase in value of crushed stone call for no special comment.

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Value of granite sold in Massachusetts in 1914 and 1915.

1914.

County.	Number of operations.	Building.		Monumental.		Paving blocks.	Crushed stone.	Other.[a]	Total value.
		Rough.	Dressed.	Rough.	Dressed.				
Berkshire, Franklin, Hampden, and Hampshire	5	$85	$82,000	$38,552	$2,000	$30,950	$6,000	$20,764	$147,657
Bristol, Plymouth, and Suffolk	14	20,545	106,677	1,322	.....	.....	62,104	28,555	251,917
Essex	17	5,955	154,448	41,991	.....	300,800	52,233	77,362	632,789
Middlesex	21	9,287	60,806	.....	16,500	50,901	9,338	78,453	224,405
Norfolk	16	4,328	31,470	368,726	16,250	490	36,382	13,455	471,091
Worcester	10	6,121	274,680	504	.....	26,540	10,474	35,259	353,578
	83	46,321	710,171	451,095	34,750	418,671	176,531	253,878	2,001,417

1915.

Berkshire, Franklin, Hampden, and Hampshire	6	$16	$40,000	$48,800	$2,000	$1,400	$13,031	$8,660	$113,907
Bristol, Plymouth, and Suffolk	14	56,184	27,245	40	345	39,820	50,716	22,023	196,373
Essex	15	81,783	270,204	.....	.....	190,002	59,461	33,180	634,630
Middlesex	16	11,415	79,049	700	4,015	38,888	12,399	85,803	232,269
Norfolk	14	3,831	1,300	370,330	6,329	.....	29,400	55,471	466,661
Worcester	13	15,035	351,159	30	.....	13,502	26,976	20,661	427,363
	78	168,264	768,957	419,900	12,689	283,612	191,983	225,798	2,071,203

[a] Other includes stone sold for riprap, rubble, curbing, flagging, and other minor uses.

MINNESOTA.

Minnesota's increase of $106,190 (14 per cent) in total value of granite in 1915, nearly offset a decrease of $117,358 in 1914. The increase was distributed among building, monumental, and paving stone, whereas the minor values for crushed stone and "other uses" decreased. Average prices, except the price of paving stone, increased. Minnesota's general increase in quantity, value, and average price during a dull year is one of the noteworthy features of the country's granite industry.

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Granite sold in Minnesota in 1914 and 1915.

1914.

County.	Number of plants.	Building (rough and dressed).		Monumental (rough and dressed).		Paving blocks.		Crushed stone.		Other value.	Total value.
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Number of blocks.	Value.	Quantity (short tons).	Value.		
Benton, Lac qui Parle, Redwood, and Renville	6	2,490	$1,725	11,582	$33,982	63,000	$4,725	.....	.....	$381	$39,813
Sherbourne	5	20,000	23,482	4,550	6,725	522,000	45,466	15,511	$19,864	7,620	103,147
Stearns	18	15,300	37,422	199,565	512,805	468,750	36,250	5,000	3,750	2,476	592,798
	29	37,790	62,629	215,647	552,602	1,123,750	86,441	20,511	23,604	10,477	735,758
Average price.	.....	.....	$1.66	.....	$2.56	Per M, $76.92		.....	$1.15	.....	.....

1915.

Benton, Lac qui Parle, Redwood, and Renville	6	17,517	$23,231	23,379	$43,349	527,715	$40,826	.....	.....	$4,119	$111,525
Sherbourne	5	25,108	30,399	14,727	32,166	595,000	44,750	12,950	$15,540	4,429	127,284
Stearns	19	27,802	65,947	181,285	497,654	747,000	38,364	.....	.....	1,169	603,134
	30	70,427	119,577	219,391	573,169	1,869,715	123,940	12,950	15,540	9,717	841,943
Average price.	.....	.....	$1.70	.....	$2.61	Per M, $66.64		.....	$1.20	.....	.....

NEW HAMPSHIRE.

Cheshire and Hillsboro are the only counties whose figures can be published separately, as the others contain less than three producers each.

Total sales of granite, which had decreased $99,446 (7 per cent) in value in 1914, decreased $149,176 (11 per cent) further in 1915. The decrease was wholly due to paving stone, whose decline in value, in spite of increased average price, was more than double the increase in dressed building and monumental stone, curbing and flagging, crushed stone, and stone for "other uses." Rough building and monumental stone showed considerable decrease in quantity and value but almost no change in average price. Dressed building stone alone showed marked decrease in average price.

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Granite sold in New Hampshire in 1914 and 1915.

1914.

County.	Number of operators.	Building.				Monumental.				Paving.		Curbing and flagging.		Crushed stone.		Other value.	Total value.
		Rough.		Dressed.		Rough.		Dressed.									
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (number of blocks).	Value.	Quantity (linear feet).	Value.	Quantity (short tons).	Value.		
Carroll, Coos, Grafton, Merrimack, and Strafford	11	16,135	$6,777	132,250	$397,202	51,649	$25,903	16,300	$61,000	2,338,658	$98,666	16,372	$5,594	12,454	$10,062	$14,931	$617,043
Cheshire	8	84,296	57,828	27,594	88,631	16,042	13,447	13,751	43,002	1,855,938	75,678	.....	.....	4,990	3,429	1,442	282,015
Hillsboro	17	58,748	20,075	6,200	5,650	55,371	54,116	34,830	107,501	5,254,512	217,136	184,375	68,980	9,000	4,500	1,755	478,623
	36	159,179	84,680	166,044	491,483	123,062	93,466	64,881	211,503	9,449,108	391,480	200,747	74,574	26,444	18,011	18,128	1,383,325
Average price	.....	.....	$0.53	.....	$2.96	.....	$0.76	.....	$3.26	Per M, $41.43		.....	$0.37	.....	$0.68	.....	.....

1915.

Carroll, Coos, Grafton, Merrimack, Rockingham, and Strafford	11	19,460	$7,694	134,868	$331,481	46,849	$22,183	20,800	$74,700	1,181,753	$49,463	21,326	$7,651	18,772	$15,471	$14,973	$523,616
Cheshire	6	14,691	5,807	79,916	210,546	8,621	6,161	17,131	56,359	884,225	36,341	.....	.....	4,174	2,946	7,927	326,087
Hillsboro	17	96,171	55,588	6,400	7,675	32,217	34,005	24,102	87,814	2,177,775	119,652	190,900	69,993	6,666	5,000	4,719	384,446
	34	130,322	69,089	221,179	549,702	87,687	62,349	62,033	218,873	4,243,753	205,456	212,226	77,644	29,612	23,417	27,619	1,234,149
Average price	.....	.....	$0.53	.....	$2.49	.....	$0.73	.....	$3.53	Per M, $48.41		.....	$0.37	.....	$0.79	.....	.....

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VERMONT.

The value of granite sold in Vermont in 1915, as in 1914, represented more than 15 per cent of the total value for the United States. In spite of a decrease of $341,727, or 11 per cent, in 1915 it was greater by more than $700,000 than Massachusetts, its closest competitor. Vermont's decrease in value in 1914 was $661,783, or nearly 18 per per cent. The total value in 1915 was less than in any previous year since 1911.

The decrease in 1915 was due in large part to dressed building stone, as in 1914, and also to rough monumental stone. Production of both building and monumental granite was much curtailed during the early part of the year by a strike lasting 11 weeks, but owing to intensified production during the remainder of the year to fill existing orders by some producers of monumental stone, especially those dressing their own stone, the decrease in total monumental stone was less than might have been expected. The output of building stone was affected, not only by the strike but by a generally poor demand. (See p. 764.)

As misinterpretation of the Survey's figures has in the past led some to believe that Vermont's granite production was underestimated, it may be repeated here that the greater part of the monumental granite reported as sold rough by the quarrymen is dressed at Barre and other centers. If this quantity of stone, after allowing 10 per cent for waste in dressing, is considered as sold at the average price for dressed stone, the total value of the combined industries of quarrying and dressing granite is more than $3,000,000 greater than the value given in the accompanying table.

The small quantity and value of paving stone shown in this table represents only the quantity made by the producers themselves. A greater quantity is made from stone sold rough by the quarrymen and reported by them as rough stone for "other purposes." There were sold from this stone by paving block contractors in 1915 about 800,000 blocks, valued at about $24,000, compared with 2,000,000 blocks, valued at $70,000, in 1914, and with 2,800,000 blocks, valued at $109,000, in 1913.

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Granite sold in Vermont in 1914 and 1915.

1914.

County.	Number of active firms reporting.	Building.				Monumental.				Paving.		Other uses.	Total value.
		Rough.		Dressed.		Rough.		Dressed.					
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (number of blocks).	Value.	Value.	
Orange, Washington, and Windsor.	22	13,037	$10,777	387,467	$1,321,434	1,387,893	$1,451,373	60,069	$195,387	.....	.....	$22,861	$3,001,832
Orleans	4	5,200	3,510	.....	.....	27,540	14,020	5,040	9,040	.....	.....	1,700	28,270
Essex and Windham	4	.....	.....	100	100	50	26	.....	.....	75,000	$3,375	.....	3,500
Caledonia	9	3,442	1,418	.....	.....	82,028	44,377	16,000	37,800	.....	.....	3,255	86,850
	39	21,679	15,705	387,567	1,321,534	1,497,511	1,509,795	81,109	242,227	75,000	3,375	27,816	3,120,452
Average price	.....	.....	$0.72	.....	$3.41	.....	$1.01	.....	$2.99	Per M, $45.00		.....	.....

1915.

Orange, Washington, and Windsor.	18	10,776	$7,803	280,169	$1,085,950	1,305,572	$1,263,831	81,771	305,743	.....	.....	$18,409	$2,681,736
Windham	3	1,255	445	.....	.....	360	228	60	160	34,800	1,430	27	2,290
Caledonia and Orleans	13	6,139	3,146	1,000	3,000	128,174	70,368	5,450	16,365	.....	.....	1,825	94,704
	34	18,170	11,394	281,169	1,088,950	1,334,106	1,334,427	87,281	322,268	34,800	1,430	20,261	2,778,730
Average price	.....	.....	$0.63	.....	$4.71	.....	$1.00	.....	$3.69	Per M, $41.09		.....	.....

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WISCONSIN.

To prevent disclosure of individual figures it was found necessary, in compiling a detailed statement of the production of granite in Wisconsin, to group together the counties of Green Lake, Jackson, and Waupaca, although these counties are not in the same part of the State. It was also necessary to include under building and monumental stone both the rough and the dressed stone, although it will readily be seen that the figures for monumental stone represent mostly dressed stone.

The total sales of granite in 1915 decreased in value $84,604 (6 per cent) as compared with that sold in 1914, which was $413,839 (45 per cent) greater than the value for 1913. The decrease in 1915 was chiefly due to crushed stone, whose decline in value was nearly twice the combined gain of building and paving. Decrease in quantity of crushed stone was in less proportion, as the average price per ton dropped 21 cents. Monumental stone also decreased in quantity and value, but its average price per cubic foot increased 24 cents.

The increase in quantity and value of paving blocks in 1915 is particularly noteworthy in comparison with the figures for 1914, when the quantity was nearly double that of 1913. The average price per thousand, which fell from $52.65 in 1913 to $43.58 in 1914, rose to $56.48 in 1915. The greater part of the paving blocks produced in the State are shipped to Chicago.

Crushed granite for roads besides supplying demand within the State, is used in Cleveland, St. Louis, Memphis, and in many other cities less distant.[1]

[1] Hotchkiss, W. O., and Steidtmann, E., Limestone road materials of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 34, p. 18, 1914.

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Granite sold in Wisconsin in 1914 and 1915.

1914.

County.	Number of operators.	Building (rough and dressed).		Monumental (rough and dressed).		Paving blocks.		Crushed stone.		Other.	Total value.
		Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (number of blocks).	Value.	Quantity (short tons).	Value.	Value.	
Douglas, Green Lake, Oconto, Polk, and Waupaca	7	.....	.....	800	$1,000	784,440	$38,127	147,979	$170,719	$120	$209,966
Marathon	5	200	$1,038	52,189	221,421	.....	.....	80	40	44	222,543
Marinette	3	9,400	564	33,909	111,150	500	20	.....	.....	203	111,937
Waushara and Marquette	11	1,952	1,788	42,227	187,203	8,566,767	509,953	90,802	79,475	18,590	797,009
	26	11,552	3,390	129,025	520,774	9,351,707	548,100	238,861	250,234	18,957	1,341,455
Average price	.....	.....	$0.29	.....	$4.04	Per M, $43.58		.....	$1.05	.....	.....

1915.

Green Lake, Jackson, and Waupaca	7	.....	.....	1,065	$1,165	1,301,655	$65,083	94,817	$84,490	$1,686	$152,424
Marathon	4	508	$2,700	46,602	214,699	.....	.....	.....	.....	263	217,662
Marinette	3	15,000	927	31,133	120,837	900	38	.....	.....	260	122,062
Waushara and Marquette	8	3,625	3,431	36,033	154,442	8,927,159	512,637	109,597	87,279	6,914	764,703
	22	19,133	7,058	114,833	491,143	10,229,714	577,758	204,414	171,769	9,123	1,256,851
Average price	.....	.....	$0.36	.....	$4.28	Per M, $56.48		.....	$0.84	.....	.....

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BASALT AND RELATED ROCKS (TRAP ROCK).

The name "trap rock," as stated in the report for 1914, has been loosely and inconsistently used in different parts of the country. The section formerly headed "trap rock," therefore, is now headed "basalt and related rocks," and the accompanying tables include, besides basalt and diabase, only those dark igneous rocks that are very similar to basalt and diabase in mineral and chemical composition and physical properties. Other rocks, formerly listed under trap rock, are now included under granite (and related rocks) and sandstone (including conglomerate or "puddingstone" and argillite or hard slate). This revision is doubtless not quite complete at present, but the quantity of granite and sandstone still included constitutes only an insignificant part of the total.

Value of basalt and related rocks (trap rock) sold in the United States, 1911–1915.

State or Territory.	1911	1912	1913	1914	1915
Arkansas	(a)	(a)	(a)	$233,987	$147,442
California	$2,055,930	$1,926,347	$2,132,245	1,589,821	1,136,589
Colorado					(b)
Connecticut	472,461	581,070	713,323	549,156	698,744
Hawaii	339,519	231,351	249,390	88,417	195,500
Massachusetts	859,070	915,241	1,194,068	691,330	632,989
Michigan	51,000	36,206	92,201	34,406	105,855
Minnesota	(a)	(a)	147,806	77,338	80,640
New Jersey	1,136,385	1,202,397	1,359,931	1,164,529	1,281,545
New York	959,966	831,667	1,077,690	895,147	762,370
Oregon	(a)	250,767	316,007	397,824	739,380
Pennsylvania	864,810	916,383	1,218,918	1,076,001	1,101,778
Texas				(a)	(b)
Washington	(a)	668,620	632,915	1,068,042	1,452,869
Wisconsin	(a)	(a)	(a)	(a)	(b)
Other States					153,521
	6,739,141	7,560,049	9,134,494	7,865,998	8,489,222

a Included under granite.

b Included in "Other States."

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Value of basalt and related rocks (trap rock) sold in the United States in 1914 and 1915.

1914.

State.	Building.	Riprap and rubble.	Paving.	Crushed stone.			Other.	Total.
				Road metal.	Railroad ballast.	Concrete.		
Arkansas	.....	$18,743	.....	$134,708	$37,432	$43,104	.....	$233,987
California	.....	350,301	$95,990	443,970	191,508	507,657	$395	1,589,821
Connecticut	$14,105	3,955	1,800	211,663	63,682	253,441	510	549,156
Hawaii	684	.....	853	37,049	17,820	32,011	.....	88,417
Massachusetts	16,410	7,625	.....	375,136	74,142	217,355	662	691,330
Michigan	.....	.....	.....	24,863	4,772	4,771	.....	34,406
Minnesota	.....	9,144	.....	4,761	.....	62,661	772	77,338
New Jersey	1,335	9,664	11,645	625,536	222,395	276,821	17,133	1,164,529
New York	4,500	.....	.....	245,484	349,430	295,733	.....	895,147
Oregon	1,355	92,924	.....	157,267	77,979	67,606	693	397,824
Pennsylvania	6,445	9,913	1,958	439,858	421,938	192,788	3,101	1,076,001
Washington	300	957,278	.....	79,727	12,269	18,468	.....	1,068,042
	45,134	1,459,547	112,246	2,780,022	1,473,367	1,972,416	23,266	7,865,996

1915.

Arkansas	.....	$6,703	.....	$50,444	$34,337	$55,958	.....	$147,442
California	$2,128	62,029	$109,197	375,896	78,052	490,057	$19,230	1,136,589
Colorado	.....	.....	.....	.....	.....	.....	.....	(a)
Connecticut	14,373	4,275	1,530	328,715	131,055	217,217	1,579	698,744
Hawaii	.....	76,958	.....	36,366	15,000	67,176	.....	195,500
Massachusetts	12,709	1,000	.....	423,548	70,686	123,586	1,460	632,989
Michigan	.....	54,000	.....	29,764	44	22,047	.....	105,855
Minnesota	.....	4,515	.....	11,305	.....	64,820	.....	80,640
New Jersey	1,547	2,056	18,033	752,960	221,579	284,731	639	1,281,545
New York	2,250	.....	.....	459,440	70,640	230,040	.....	762,370
Oregon	9,352	285,053	2,200	202,580	80,433	151,399	8,363	739,380
Pennsylvania	9,898	10,868	1,703	408,949	474,484	195,257	619	1,101,778
Texas	.....	.....	.....	.....	.....	.....	.....	(a)
Washington	50	1,353,367	3,397	93,167	2,388	500	.....	1,452,869
Wisconsin	.....	.....	.....	.....	.....	.....	.....	(a)
Other States	.....	.....	10,500	42,973	16,175	83,873	.....	153,521
	52,307	1,860,824	146,560	3,216,107	1,194,873	1,986,661	31,890	8,489,222

a Included in "Other States."

The figures in the foregoing table show a steady increase in total value up to 1914, when there was a decrease of $1,268,496, or nearly 14 per cent. About half this amount, or more than 7 per cent of the value for 1914, was regained in 1915.

Of the 14 States credited with production in 1915, only 4, Arkansas, California, Massachusetts, and New York, showed decrease in total value, whereas all except 3, Arkansas, Oregon, and Washington, showed decrease in 1914. Washington became the leading producer in 1915, displacing California. Other States with production valued at more than $1,000,000 in 1915 were New Jersey and Pennsylvania.

The bulk of basalt and related rocks is used for crushed stone, that for road metal exceeding that for concrete, which in turn exceeds that for railroad ballast. Increase in value for the first two uses is recorded for 1915. Further discussion of the subject is given on pages 825–842.

Riprap and rubble are next to crushed stone in importance, especially in Washington and California, and have increased in total value during the last two years. The increased production in Washington in the last few years, which accounts for the increased

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total value of the State, has been used in the construction of breakwaters; the marked decrease in California was due to completion of similar structures.

Paving blocks of diabase and basalt increased in quantity and value in 1915, as shown in the table below. They have been an important product only in California, where the quantity sold has exceeded $100,000 in most years. New Jersey and Connecticut are the only other States where annual sales exceed $10,000 in value, Colorado appearing as a producing State for the first time in 1915.

Paving blocks of basalt and related rocks (trap rock) sold in the United States in 1914 and 1915.

State.	1914		1915	
	Number.	Value.	Number.	Value.
California	2,127,143	$95,990	2,689,219	$109,197
Colorado			140,000	10,500
Connecticut	45,000	1,800	38,250	1,530
Hawaii	64,000	853		
New Jersey	506,674	11,645	479,400	18,033
Oregon			60,000	2,200
Pennsylvania	119,000	1,958	39,600	1,703
Washington			133,233	3,397
	2,861,817	112,246	3,579,702	146,560
Average price per thousand		39.22		40.94

Building stone also increased in 1915 but represented only a small fraction of the total value. It finds only a local market.

MARBLE.

MARKETED PRODUCTION.

The figures for marketed production of marble here presented include for some States the value of serpentine (verde antique) and "onyx marble." These products are considered separately on page 801.

Owing to the small number of producers in many of the marble-producing States, it is not possible to compile a satisfactory table showing the marble produced by States. The figures are given, however, as far as they are available.

In 1915 the commercial output of marble came from the following States, arranged according to value of output:

VERMONT: Addison, Chittenden, Franklin, Grand Isle, Rutland, and Washington counties.
GEORGIA: Cherokee and Pickens counties.
TENNESSEE: Blount, Knox, Loudon, and Union counties.
COLORADO: Gunnison County.
ALABAMA: Talladega County.
MASSACHUSETTS: Berkshire and Hampden counties.
NEW YORK: Dutchess, St. Lawrence, Warren, and Westchester counties.
ALASKA: Tokeen, Ketchikan mining district, southeastern Alaska.
MISSOURI: Green and Jasper counties.
MARYLAND: Baltimore and Harford counties.
PENNSYLVANIA: Chester, Montgomery, and Northampton counties.
NORTH CAROLINA: Cherokee County.
CALIFORNIA: Inyo, Los Angeles, and Tuolumne counties.
ARKANSAS: Independence and Searcy counties.
UTAH: Tooele and Utah counties.

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TEXAS: San Saba County.
KENTUCKY: Barren County.
VIRGINIA: Rockingham County.
NEW MEXICO: Otero County.
SOUTH CAROLINA: Oconee County.
OREGON: Josephine County.

The value of marble sold by producers in 1915, as shown in the following table, decreased $1,205,387, or 15 per cent, compared with that sold in 1914, and was less than in any year since 1909, when the value was $6,548,905, from which time it had steadily increased by small percentages until 1914 when the value exceeded all previous records.

More than half the decrease in value in 1915 was in Vermont, $698,207. Tennessee's decrease was next largest, $294,512, and Georgia's third, $217,137. Massachusetts and "Other States," foremost of which were Colorado and Alabama, were the only ones to show increase. Missouri's figures for 1915 include a part of the sales from the Carthage district, which were formerly reported under limestone. The general decline is attributed mainly to depressed conditions that affected the stone industry of the whole country, although local causes, such as shortage of labor, contributed to some extent.

Value of marble sold in the United States, 1911–1915.

State or Territory.	1911	1912	1913	1914	1915
Alabama	[a]$335,005	(b)	(b)	$370,766	(b)
Alaska	(a)	(b)	(b)	(b)	(b)
Arizona	(a)				
Arkansas	(a)	(b)	(b)	(b)	(b)
California	29,964	$76,424	$72,768	70,451	$47,976
Colorado	[a]1,010,840	(b)	(b)	(b)	(b)
Georgia	1,088,422	1,096,622	1,101,997	1,190,742	973,605
Kentucky	(a)	(b)		(b)	(b)
Maryland	[a]73,300	(b)	(b)	(b)	(b)
Massachusetts	219,445	213,939	276,819	206,883	223,208
Missouri	(c)	(c)	(c)	(b)	122,238
New Mexico	(a)	(b)	(b)	(b)	(b)
New York	379,670	291,210	252,982	243,787	202,843
North Carolina	(a)	(b)	(b)	(b)	(b)
Oklahoma	(a)				
Oregon			(b)		(b)
Pennsylvania	214,913	267,242	(b)	(b)	60,819
South Carolina	(a)				(b)
Tennessee	700,229	974,733	1,416,952	1,253,549	959,037
Texas				(b)	(b)
Utah	(a)	(c)	(b)	(b)	(b)
Vermont	3,394,930	3,494,253	3,513,405	3,490,971	2,792,764
Virginia		(c)	(b)	(b)	(b)
Washington			(b)	(b)	
Other States		1,372,035	1,235,967	1,239,263	1,533,540
Total	7,546,718	7,786,458	7,870,890	8,121,412	6,916,025

[a] Alabama includes Kentucky and Oklahoma; Colorado includes Alaska, Arizona, New Mexico, Oregon, and Utah; Maryland includes North Carolina and South Carolina.
[b] Included in "Other States."
[c] Included in limestone.

Most marble quarrymen report their output from year to year, using the same unit, so that a comparison both of the quantities sold annually by the cubic foot or the square foot or the ton and of their corresponding values is possible. The greater part of the marble quarried is sold by the cubic foot, as shown in the following table:

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Marble sold in the United States, 1913–1915.

		1913		1914		1915	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Rough:							
Monumental	cubic feet	912,792	$1,361,592	814,905	$1,168,493	732,272	$1,005,068
	short tons	32	314				
Building, exterior	cubic feet	809,114	969,814	713,283	913,247	684,224	802,377
	short tons	4,000	3,400	32,679	26,909	5,000	3,900
	square feet			3,000	840		
Building, interior	cubic feet	858,611	1,287,938	847,767	1,317,538	697,997	1,133,366
	short tons	2,300	805	2,300	805	2,300	805
	square feet	1,000	2,000	649	616		
Dressed:							
Monumental	cubic feet	256,300	1,135,658	241,229	1,134,991	192,445	868,600
Building, exterior	do	288,754	829,244	343,592	1,207,274	367,301	1,213,964
Building, interior	cubic feet	309,375	1,732,002	433,766	2,080,690	395,512	1,695,059
	square feet	375,648	137,260	250	375	10,000	15,000
Ornamental	cubic feet	2,650	34,850	1,700	20,200	1,650	19,950
Other uses	cubic feet	169,222	234,173	65,755	102,393	3,810	476
	short tons	99,752	121,840	159,228	144,864	157,533	156,864
	square feet			46,228	2,177	19,592	596
Total	cubic feet	3,606,818	7,605,271	3,461,997	7,942,826	3,075,211	6,738,860
	short tons	106,084	126,359	194,207	172,578	164,833	161,569
	square feet	376,648	139,260	50,127	4,008	29,592	15,596
			7,870,890		8,121,412		6,916,025

According to this table there has been, for monumental and exterior building work, a steady decrease during 1913, 1914, and 1915 in quantity and value of rough marble, and, for interior building work, a steady decrease in quantity but increase in value in 1913 and 1914, and a decrease in both in 1915. Dressed marble for monumental work has steadily decreased in quantity and value; that for exterior building has increased in both respects; and that for interior building has fluctuated, decreasing markedly in both quantity and value in 1915. Marble for ornamental work has decreased steadily in quantity and value; and marble for "other uses," though fluctuating somewhat in quantity, has also steadily decreased in value.

Building stone represents by far the greater part of the marketed production of marble—about two and two-thirds as much as monumental stone. About three-fifths of both exterior and interior building stone is reported as dressed at the quarry, and the proportion dressed at the quarry has, as a whole, been increasing, except for the marked decline in dressed interior building stone in 1915. A little more than half the monumental stone is sold rough and the ratio of rough to dressed stone has remained fairly uniform.

"Other marble" includes, as rough stone the waste marble sold to lime burners, to carbonic-acid factories, to pulp mills, to iron furnaces for flux, and that used for making roads; as dressed stone, that sold for mosaics and electrical work.

In the table on page 800 are shown great differences in the ratio of quantity to value in different States. Whereas the value in Vermont in 1915 was nearly three times that in Georgia, the quantities in the two States were nearly equal. The difference is chiefly due to the fact that much of the Vermont marble was dressed by the producers and brought an average price of $3.20 per cubic foot, whereas the

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Georgia marble was practically all sold rough at an average price of $1.10 per cubic foot. Tennessee marble, which brought an average price of $1.79 per cubic foot, was evidently sold largely as rough. The average prices per cubic foot in 1914 were $3.17 in Vermont, $1.24 in Georgia, and $1.94 in Tennessee.

The average price per cubic foot in Massachusetts was $2.01 in 1915, compared with $1.61 in 1914. This is an average of a small quantity of serpentine from Westfield, which sold for considerably more than the average price, and of the white marble from Lee.

The average price in New York, representing the white marble from Dover, the gray from Gouverneur, and the black from Glens Falls, was $1.53 in 1915 and $1.69 in 1914. The low average price per cubic foot in Missouri, in 1915, 92 cents, was due to the fact that the greater part of the stone was reported as sold rough. A small quantity of dressed marble was reported from Carthage. The average price in California was $1.82 in 1915 and $2.09 in 1914.

Marble sold in California, Georgia, Massachusetts, Missouri, New York, Tennessee, and Vermont in 1914 and 1915.

State.	1914		1915	
	Quantity.	Value.	Quantity.	Value.
California:				
Short tons	840	$6,540	630	$4,110
Cubic feet	30,059	62,730	24,131	43,866
Square feet	787	1,181	.....	.....
	.....	70,451	.....	47,976
Georgia:				
Short tons	21,241	35,000	22,200	39,360
Cubic feet	929,209	1,155,742	848,633	934,245
	.....	1,190,742	.....	973,605
Massachusetts:				
Short tons	9,539	13,290	12,590	20,058
Cubic feet	119,864	193,593	100,879	208,147
	.....	206,883	.....	228,205
Missouri:				
Cubic feet	.....	(a)	131,522	121,042
Square feet	.....	.....	19,592	596
	.....	(a)	.....	122,238
New York:				
Short tons	45,953	40,176	59,603	53,149
Cubic feet	122,958	207,771	97,949	149,694
Square feet	3,000	840	.....	.....
	.....	248,787	.....	202,843
Tennessee:				
Short tons	2,000	634	.....	.....
Cubic feet	646,354	1,252,915	535,929	959,087
	.....	1,253,549	.....	959,087
Vermont:				
Short tons	6,300	4,205	6,900	4,355
Cubic feet	1,100,902	3,486,766	870,656	2,788,379
	.....	3,490,971	.....	2,792,734

a Included in limestone in 1914.

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SERPENTINE (VERDE ANTIQUE).

The serpentine classed as marble in this report is that variety which from its use as ornamental stone, answers the purpose of marble. A small quantity has been quarried in some years for building stone but no sales for this use were reported in 1915. Sales in 1915 were reported from the following six States, arranged according to value: Vermont, Pennsylvania, Massachusetts, Maryland, Georgia, and California, two producers reporting from Pennsylvania and one from each of the other States. The quantity and value were reported as follows: 46,126 cubic feet, $183,544; 10,000 square feet, $15,000; 2,765 tons, $5,648; total, $204,192.

ONYX MARBLE.

"Onyx" marble or travertine, also called "cave onyx," is quarried in small quantity annually. In 1915 sales were reported from Utah, Kentucky, and New Mexico, and the total output was 4,574 cubic feet, valued at $19,270, or $4.21 per cubic foot. Small quantities have been quarried from time to time in Virginia and made into small ornaments such as paper weights, brooches, watch charms, and hatpins.

LOCAL DEVELOPMENT.

In Vermont two new companies that were developing their quarries in 1914 reported production in 1915. A new property near East Dorset, containing white and variegated marble and owned by Duffy & McTierney, of Rutland, Vt., has been prospected by drill to a depth of 70 feet, and it is said that a quarry will be opened in it in 1916. New discoveries of pale-green (crenulated chrome) marble in Clarendon have been reported by E. H. Foley, also of Rutland.

At Gouverneur, N. Y., the Northern New York Marble Co. was consolidated with the Gouverneur Marble Co.

At Cockeysville, Md., a new brown variety of marble has been opened on the property of the Beaver Dam Marble Co.

At Ishpeming, Mich., development work on a serpentine deposit has been carried on, but no stone was sold in 1915.

The marketed production of marble from Phenix and Carthage, Mo., is reported as such for the first time in this report. The use of the stone for ornamental interior and monumental work has grown in recent years, and in 1915 more than three companies reported sales of marble, whereas in former years all but the one company at Phenix reported their sales under the heading of limestone.

The Utah the Bird's-Eye Marble Co. was reorganized as the Mount Nebo Marble Co., of Salt Lake City, which continued to quarry the bird's-eye marble near Clinton and the travertine near Low, besides reopening a travertine vein that was worked several years ago at Pelican Point. The Travertine Onyx Co. of America with offices at Salt Lake City and Denver, and property near Low was developing a quarry and produced some stone in 1915.

In Alaska the newly opened quarry of the Mission Marble Works, at Orr Inlet, has been sold to the Mission-Alaska Quarry Co., an affiliated corporation, the former continuing to handle the product shipped from the quarry. A small shipment was made from the

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quarry late in 1915, and plans are under way for increased activity in 1916. Prospecting with core drills has been carried on by the Vermont Marble Co. at several places in the same district. The Vermont Marble Co. also reported a production for the first time at San Saba, Tex.

LIMESTONE.

MARKETED PRODUCTION.

GENERAL STATISTICS.

The value of limestone sold in 1915, as shown in the accompanying table, was greater by $1,335,711, or 4 per cent, than that in 1914, which had dropped nearly 13 per cent below the record value of 1913. Gains in 1915 were made by 22 States, most conspicuous of which were Pennsylvania, with an increase of more than $1,000,000; Michigan and Virginia, with increases of more than $300,000; and Ohio, with an increase of nearly $275,000. Losses were sustained by 21 States also, most conspicuous of which were Alabama, with a decrease of more than $360,000; Missouri and Kentucky, with decreases of more than $200,000; and New York and Wisconsin, with decreases of more than $100,000.

The values recorded for Pennsylvania, Michigan, Virginia, and Tennessee were greater than in any previous year.

The leading States, according to rank, in 1915 were Pennsylvania, Ohio, Indiana, New York, Illinois, Missouri, Michigan, and Virginia, each with a value of more than $1,000,000. All but New York and Missouri showed increase over their value in 1914. The same order was held in 1914, except that Kentucky slightly preceded Virginia. Kentucky and Wisconsin fell below $1,000,000 in 1915. Pennsylvania's value in 1915 was 18 per cent of the total, compared with less than 16 per cent in 1914. Three-quarters of it was represented by furnace flux and the rest chiefly by crushed stone. Ohio's value in both 1914 and 1915 was more than 12 per cent of the total, 59 per cent represented by crushed stone and 30 per cent by furnace flux in 1915. Indiana's value was about 12 per cent of the total in both 1914 and 1915, more than 70 per cent being represented by building stone in 1915.

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Value of limestone produced and sold in the United States, 1911 to 1915.

State.	1911	1912	1913	1914	1915
Alabama	$571,798	$531,085	$812,664	$787,214	$426,266
Arizona	8,676	19,099	6,328	(a)	9,800
Arkansas	b 136,007	66,952	52,220	47,390	32,917
California	576,701	245,235	323,287	286,273	338,179
Colorado	341,798	365,004	428,736	340,059	337,899
Connecticut	b 21,040	17,924	(a)	(a)	26,246
Florida	97,520	60,524	156,589	343,779	354,673
Georgia	31,632	53,187	83,899	89,216	86,254
Hawaii					(a)
Idaho	b 19,497	19,791	18,569	28,032	(a)
Illinois	3,436,977	3,808,784	4,112,172	2,861,340	2,864,103
Indiana	4,406,577	5,066,337	4,649,597	4,115,557	4,204,092
Iowa	679,895	944,885	803,682	537,362	535,656
Kansas	789,448	757,197	824,005	598,302	535,240
Kentucky	1,124,170	1,160,148	1,069,034	1,196,046	993,388
Louisiana	(b)	(a)	(a)	(a)	(a)
Maine	(b)	(a)	(a)	(a)	
Maryland	218,636	228,713	282,241	204,276	180,723
Massachusetts	(b)	(a)	(a)	(a)	(a)
Michigan	1,001,535	1,139,560	1,408,708	1,457,961	1,828,766
Minnesota	612,915	546,650	636,620	489,849	395,763
Missouri	2,179,767	2,373,725	2,486,020	2,160,958	1,927,534
Montana	148,126	154,133	260,915	207,321	228,637
Nebraska	263,459	335,369	326,287	302,862	320,341
Nevada	(b)	(a)			
New Jersey	138,148	205,334	280,680	240,937	159,549
New Mexico	243,119	237,543	148,266		(a)
New York	2,857,797	3,208,911	3,539,043	3,158,617	3,018,871
North Carolina	30,278	39,864	67,132	58,754	82,672
Ohio	4,461,882	4,885,088	4,945,310	4,131,917	4,405,590
Oklahoma	594,664	409,994	246,912	237,044	398,636
Oregon	(b)	(a)	(a)	(a)	(a)
Pennsylvania	5,243,045	6,017,308	6,189,145	5,270,458	6,367,446
Rhode Island	(b)	(a)	(a)	(a)	(a)
South Carolina	(b)				(a)
South Dakota	6,250	10,628	4,098	12,488	17,485
Tennessee	b 798,389	673,329	643,586	678,068	855,245
Texas	490,289	530,251	590,289	549,567	492,255
Utah	168,145	208,245	368,007	303,081	196,271
Vermont	19,702	12,644	17,715	24,049	49,405
Virginia	369,872	403,069	598,032	1,194,261	1,534,545
Washington	32,478	20,370	62,913	10,008	11,550
West Virginia	902,077	981,467	1,046,625	778,749	922,766
Wisconsin	848,363	853,477	1,017,135	1,007,106	894,158
Wyoming	36,960	64,749	108,234	50,500	(a)
Other States		73,227	130,734	134,254	196,945
	33,897,612	36,729,800	38,745,429	33,894,155	35,229,866

a Included in "Other States."
b Arkansas includes Louisiana; Connecticut includes Maine, Massachusetts, and Rhode Island; Idaho includes Nevada and Oregon; Tennessee includes South Carolina.

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Value of limestone sold in the United States in 1914 and 1915.

1914.

State.	Rough building.	Dressed building.	Paving.	Curbing.	Flagging.	Rubble.	Riprap.
Alabama	$20,992	$20,558					$3,882
Arizona							
Arkansas	4,923	33,369				$176	1,812
California	385						
Colorado							
Connecticut [a]							
Florida	60,000						974
Georgia	187						
Idaho	180						
Illinois	15,129	29,706	$9,600	$140		73,643	127,394
Indiana	965,439	1,717,951	4,801	84,188	$160	21,764	15,967
Iowa	21,747	10,585	5,519	905		26,871	69,611
Kansas	16,526	12,060		325	124	28,741	6,573
Kentucky	59,804	60,805	40	7,132		4,115	21,666
Louisiana [a]							
Maine [a]							
Maryland	6,722	15	9,750		25		420
Massachusetts [a]							
Michigan	3,537					1,651	6,727
Minnesota	25,166	136,479		450	685	20,440	48,801
Missouri	168,984	148,037	7,350	500	3,967	126,172	482,753
Montana	3,916						724
Nebraska	1,416					761	43,355
New Jersey							1,000
New York	60,227	13,708		3,340	38	3,620	30,891
North Carolina							
Ohio	48,543	5,528	97			50,403	38,902
Oklahoma	1,850	45,134	450			300	19,815
Oregon [a]							
Pennsylvania	67,869	1,215	70,420	3,073		6,970	2,436
Rhode Island [a]							
South Dakota	8					800	600
Tennessee	6,760		4,500	80		3,200	17,159
Texas	28,853	17,434		243	6	935	81,424
Utah	7,300					13,588	6,381
Vermont	4,194					400	
Virginia	2,049	715				120	
Washington							
West Virginia	300		1,800	900		1,500	90
Wisconsin	39,621	928	550	19,131	2,129	37,166	69,959
Wyoming							
Other States							23,807
	1,642,627	2,254,227	114,877	120,407	7,134	423,336	1,123,123

[a] Included in "Other States."

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Value of limestone sold in the United States in 1914 and 1915—Continued.

1914—Continued.

State.	Crushed stone.			Flux.	Sugar factories.	Agricultural.	Lime burners.	Other.	Total value.
	Road metal.	Railroad ballast.	Concrete.						
Alabama	$75,528	$1,076	$287,119	$360,691	.....	$17,368	.....	.....	$787,214
Arizona	.....	.....	.....	.....	.....	.....	.....	.....	(a)
Arkansas	432	.....	4,460	.....	.....	2,218	.....	.....	47,390
California	66,948	904	67,252	43,766	$75,736	3,597	.....	$27,685	286,273
Colorado	.....	.....	.....	277,355	58,193	.....	$1,987	2,524	340,059
Connecticut	.....	.....	.....	.....	.....	.....	.....	.....	(a)
Florida	84,911	82,596	90,986	.....	.....	24,312	.....	.....	343,779
Georgia	34,200	.....	11,620	2,722	.....	37,172	.....	3,315	89,216
Idaho	.....	.....	.....	.....	27,852	.....	.....	.....	28,032
Illinois	828,863	372,843	928,827	283,398	.....	88,763	.....	103,034	2,861,340
Indiana	1,065,360	69,089	43,767	85,047	2,120	27,436	.....	12,468	4,115,557
Iowa	17,438	97,747	278,071	1,200	.....	7,352	.....	316	537,362
Kansas	20,135	274,000	222,302	455	.....	3,205	.....	13,856	598,302
Kentucky	323,075	615,621	56,739	21,287	.....	23,468	.....	2,294	1,196,046
Louisiana	.....	.....	.....	.....	.....	.....	.....	.....	(a)
Maine	.....	.....	.....	.....	.....	.....	.....	.....	(a)
Maryland	116,284	30,061	36,343	1,380	.....	1,200	735	1,341	204,276
Massachusetts	.....	.....	.....	.....	.....	.....	.....	.....	(a)
Michigan	242,839	20,600	166,959	565,012	69,477	11,104	.....	370,055	1,457,961
Minnesota	21,557	7,500	216,903	180	2,100	925	.....	8,663	489,849
Missouri	363,302	137,428	613,759	29,866	2,673	7,958	75	68,134	2,160,958
Montana	1,271	56	32,639	158,801	10,414	.....	.....	.....	207,821
Nebraska	27,300	2,626	216,089	9,000	2,300	.....	.....	15	302,862
New Jersey	13,701	.....	9,838	136,038	.....	74,760	.....	5,600	240,937
New York	1,085,982	564,863	765,673	407,543	.....	81,035	.....	141,697	3,158,617
North Carolina	8,685	.....	1,075	10,552	.....	38,442	.....	.....	58,754
Ohio	746,400	442,060	419,970	1,072,754	1,506	33,947	45,898	255,909	4,131,917
Oklahoma	7,441	75,947	83,714	630	.....	1,274	.....	489	237,044
Oregon	.....	.....	.....	.....	.....	.....	.....	.....	(a)
Pennsylvania	547,712	291,977	524,175	3,563,571	.....	72,789	21,197	97,054	5,270,458
Rhode Island	.....	.....	.....	.....	.....	.....	.....	.....	(a)
South Dakota	8,800	.....	2,270	.....	.....	.....	.....	10	12,488
Tennessee	264,288	220,333	85,467	62,893	.....	13,388	.....	.....	678,068
Texas	104,898	42,360	241,559	30,780	.....	.....	438	637	549,567
Utah	19,200	.....	.....	235,487	21,125	.....	.....	.....	303,081
Vermont	9,610	.....	2,515	400	.....	.....	.....	6,930	24,049
Virginia	576,869	355,404	75,685	134,287	.....	29,543	10,559	9,030	1,194,261
Washington	.....	.....	.....	.....	.....	1,800	.....	8,208	10,008
West Virginia	108,490	208,534	32,005	391,017	.....	33,251	862	.....	778,749
Wisconsin	508,870	42,653	210,921	28,341	.....	3,293	3,141	10,403	1,007,106
Wyoming	.....	.....	200	.....	50,300	.....	.....	.....	50,500
Other States	127	11,070	35,115	5,916	.....	49,361	.....	8,858	134,254
	8,300,516	3,967,348	5,794,017	7,890,369	323,796	688,961	84,892	1,158,525	33,894,155

a Included in "Other States."

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Value of limestone sold in the United States in 1914 and 1915—Continued.

1915.

	Rough building.	Dressed building.	Paving.	Curbing.	Flagging.	Rubble.	Riprap.
Alabama	$6,912	$15,487	.....	.....	.....	$800	$18,379
Arizona	.....	.....	.....	.....	.....	.....	7,800
Arkansas	64	.....	.....	.....	.....	244	660
California	3,500	.....	.....	.....	.....	.....	.....
Colorado	.....	.....	.....	.....	.....	.....	.....
Connecticut	.....	.....	.....	.....	.....	1,336	.....
Florida	15,000	70,000	.....	.....	.....	.....	2,438
Georgia	200	.....	.....	.....	.....	.....	.....
Hawaii[a]	.....	.....	.....	.....	.....	.....	.....
Idaho[a]	.....	.....	.....	.....	.....	.....	.....
Illinois	8,250	5,400	$1,292	$175	$60	47,717	225,454
Indiana	1,011,560	1,935,367	8	64,026	2,522	17,338	16,741
Iowa	28,949	3,716	9,015	25	140	13,882	92,182
Kansas	19,621	14,198	1,357	526	86	16,554	48,090
Kentucky	66,373	47,134	400	4,782	536	2,925	34,083
Louisiana[a]	.....	.....	.....	.....	.....	.....	.....
Maryland	3,930	.....	.....	.....	.....	.....	.....
Massachusetts[a]	.....	.....	.....	.....	.....	.....	.....
Michigan	4,262	.....	200	.....	.....	743	104
Minnesota	34,738	80,937	.....	.....	140	22,198	58,697
Missouri	60,203	337,004	800	210	2,529	132,458	323,918
Montana	6,298	.....	2,606	.....	.....	60	55
Nebraska	2,319	.....	.....	.....	.....	800	54,458
New Jersey	275	.....	.....	.....	.....	.....	225
New Mexico[a]	.....	.....	.....	.....	.....	.....	.....
New York	50,040	17,644	392	1,457	550	2,084	2,929
North Carolina	.....	.....	.....	.....	.....	.....	.....
Ohio	59,725	2,733	.....	.....	.....	848	66,170
Oklahoma	501	743	.....	500	.....	228	29,196
Oregon[a]	.....	.....	.....	.....	.....	.....	.....
Pennsylvania	49,150	695	1,826	28	105	4,637	2,057
Rhode Island[a]	.....	.....	.....	.....	.....	.....	.....
South Carolina[a]	.....	.....	.....	.....	.....	.....	.....
South Dakota	.....	.....	.....	.....	.....	.....	8,875
Tennessee	166	.....	.....	.....	.....	2,324	187,447
Texas	18,191	32,169	.....	135	.....	576	28,431
Utah	2,700	320	.....	.....	.....	.....	.....
Vermont	1,095	.....	.....	.....	.....	1,000	.....
Virginia	1,400	1,018	.....	.....	.....	200	6,160
Washington	997	.....	.....	.....	.....	.....	.....
West Virginia	.....	.....	.....	.....	.....	1,500	.....
Wisconsin	31,917	2,691	1,500	8,551	1,090	35,664	76,470
Wyoming[a]	.....	.....	.....	.....	.....	.....	.....
Other States	300	.....	.....	.....	.....	.....	14,619
	1,488,945	2,567,256	19,396	80,415	7,758	306,116	1,305,636

[a] Included in "Other States."

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Value of limestone sold in the United States in 1914 and 1915—Continued.

1915—Continued.

	Crushed stone.			Flux.	Sugar factories.	Agricultural.	Other.	Total value.
	Road metal.	Railroad ballast.	Concrete.					
Alabama	$42,116	$554	$45,443	$289,167	.....	$7,386	$22	$426,266
Arizona	.....	.....	.....	1,330	$570	.....	100	9,800
Arkansas	9,600	3,756	13,800	38	.....	4,717	38	32,917
California	78,970	17,703	27,180	70,087	120,965	11,519	8,255	338,179
Colorado	.....	.....	.....	272,093	63,027	.....	2,779	337,899
Connecticut	160	.....	1,442	1,675	.....	21,633	.....	26,246
Florida	56,381	50,000	108,003	.....	.....	52,851	.....	354,673
Georgia	23,000	.....	16,600	3,453	.....	39,751	3,250	86,254
Hawaii	.....	.....	.....	.....	.....	.....	.....	(a)
Idaho	.....	.....	.....	.....	.....	.....	.....	(a)
Illinois	706,405	341,126	1,072,180	348,547	.....	82,450	25,038	2,864,103
Indiana	910,462	55,649	33,262	69,834	11,706	36,908	38,409	4,204,092
Iowa	28,315	78,886	261,541	2,905	141	15,907	52	535,656
Kansas	15,591	169,117	222,524	533	.....	1,144	25,899	535,240
Kentucky	379,234	327,578	78,652	19,259	.....	31,303	1,129	993,388
Louisiana	.....	.....	.....	.....	.....	.....	.....	(a)
Maryland	78,865	31,367	63,152	2,059	.....	200	1,150	180,723
Massachusetts	.....	.....	.....	.....	.....	.....	.....	(a)
Michigan	194,970	19,640	217,304	763,029	46,143	9,746	572,625	1,828,766
Minnesota	4,218	.....	177,093	664	2,100	970	14,008	395,763
Missouri	378,086	82,005	513,763	26,591	5,577	4,841	59,549	1,927,534
Montana	5,186	178	8,303	189,576	16,375	.....	.....	228,637
Nebraska	.....	11,913	249,269	.....	1,584	.....	.....	320,341
New Jersey	8,994	750	5,462	141,915	.....	1,598	330	159,549
New Mexico	.....	.....	.....	.....	.....	.....	.....	(a)
New York	1,077,018	614,875	599,302	416,712	.....	99,553	136,315	3,018,871
North Carolina	6,388	.....	.....	17,000	.....	59,284	.....	82,672
Ohio	1,547,167	603,599	448,516	1,321,921	.....	56,367	298,544	4,405,590
Oklahoma	29,689	205,765	130,732	.....	236	.....	1,046	398,636
Oregon	.....	.....	.....	.....	.....	.....	.....	(a)
Pennsylvania	661,547	172,708	392,267	4,799,546	.....	117,903	164,977	6,367,446
Rhode Island	.....	.....	.....	.....	.....	.....	.....	(a)
South Carolina	.....	.....	.....	.....	.....	.....	.....	(a)
South Dakota	4,000	.....	1,050	.....	3,525	.....	35	17,485
Tennessee	369,296	132,655	86,027	49,545	.....	25,360	2,425	855,245
Texas	151,495	24,100	209,602	25,280	.....	500	1,776	492,255
Utah	3,750	.....	2,810	158,691	28,000	.....	.....	196,271
Vermont	10,465	.....	1,500	254	.....	31,573	3,518	49,405
Virginia	839,858	408,830	71,686	126,623	.....	65,554	13,216	1,534,545
Washington	212	.....	.....	19	752	606	8,964	11,550
West Virginia	114,770	219,839	32,874	518,827	.....	34,112	844	922,766
Wisconsin	426,993	20,537	225,833	33,666	.....	9,075	20,141	894,158
Wyoming	.....	.....	.....	.....	.....	.....	.....	(a)
Other States	1,029	11,126	17,337	1,478	80,337	70,719	.....	196,945
	8,164,230	3,604,256	5,334,509	9,672,347	381,038	893,530	1,404,434	35,229,866

a Included in "Other States."

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As appears in the table on pages 804-807, showing the value of limestone by States and uses, the increase in total value was due mainly to stone used for flux, whose increase ($1,781,978) exceeded the sum of all decreases ($1,365,261). Other products to show considerable increase in 1915 were dressed building stone, agricultural stone, riprap, and stone for "other uses." The largest decrease ($958,886) was for crushed stone, and considerable decreases were also shown by rough building stone, rubble, and paving stone.

The figures in the foregoing tables represent only the quantity of limestone sold or used as such by the producers. In addition, large quantities of limestone are used in the manufacture of Portland cement and lime. A relatively small quantity is used in the manufacture of natural cement. As these products are manufactured by companies quarrying the stone, and as the value of the manufactured product is given in other chapters of Mineral Resources, the value of the raw material is excluded from the tables of this chapter to avoid duplication. Estimates of the quantity of limestone used in these industries in 1915 are as follows:

	Short tons.
Portland cement	24,095,355
Natural cement	153,060
Lime	7,179,358
	[1]31,427,773

The average price per ton of limestone for Portland cement, based on information by producers in various States, was 35 cents in 1915. No price per ton for crude rock has been stated by producers of natural cement. If it is assumed to average the same as that of limestone for Portland cement, the total value of limestone for cement was approximately $8,486,945. The average price per ton of limestone sold by producers to lime burners, given in the table on page 816, was 66 cents. If this is assumed as the average price of stone quarried by lime burners themselves, the total value of this stone is about $4,738,376. The grand total value of limestone quarried by manufacturers of cement and lime was $13,225,321.

BUILDING STONE.

In both 1914 and 1915 more than 11 per cent of the total value of limestone sold as such was represented by building stone. The total value of building stone, which decreased $612,485 (14 per cent) in 1914, increased $159,347 (4 per cent) in 1915. The increase was due to dressed stone, which increased $313,029 and overshadowed a decrease of $153,682 in the value of rough stone. Indiana, by far the foremost State in production of limestone for building, and Missouri, the second State, increased in value of total sales in 1915 and more than offset decreases in Minnesota and Kentucky, the third and fourth States. These four States represented more than 88 per cent of the total value of limestone sold for building in 1915.

Indiana's total sales of building stone amounted in value to $2,947,227 in 1915, a gain of $263,837, or nearly 10 per cent, over the figures for 1914, but not equal to the value for 1913 ($3,108,005). The value in 1915 represented 69 per cent of the total value of lime-

[1] The total quantity for these uses was estimated by E. C. Eckel (Eng. and Min. Jour., Dec. 5, 1914, p. 989) to be 24,950,000 tons in 1912 and 27,290,000 tons in 1913. These figures represented 29 per cent for each year of the estimated quantity used for all purposes.

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stone for building, as it did in 1914 and 1913; it also represented 19 per cent of the total value of all kinds of building stone sold in the United States in 1915, compared with 15 per cent in 1914.

Bedford district, Ind.—Most of the product of Indiana is quarried in Lawrence and Monroe counties, and is well known to the trade as "Bedford oolitic limestone," after the town of Bedford, Lawrence County, which, with Bloomington, Monroe County, forms the shipping center of this stone. This Bedford stone is chiefly used for building, although some is sold for flagstone, curbstone, monumental stone, crushed stone, ground limestone, furnace flux, and some—not included in this report—is used for lime and cement.

As this stone is so large a factor in the building limestone trade, the following tables are given to show the details of the marketed production of Bedford oolitic limestone in Lawrence and Monroe counties from 1901 to 1915:

Bedford oolitic limestone quarried and sold in Lawrence and Monroe counties, Ind., 1901–1915.

Year.	Lawrence County.		Monroe County.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1901	.....	$1,365,875	.....	$421,599	.....	$1,787,474
1902	.....	1,207,497	.....	439,902	.....	1,637,399
1903	.....	1,088,477	.....	487,662	.....	1,576,139
1904	.....	1,054,302	.....	589,672	.....	1,643,974
1905	.....	1,550,076	.....	843,399	.....	2,393,475
1906	.....	1,460,743	.....	1,162,062	[a] 9,282,004	2,622,805
1907	.....	1,413,280	.....	908,612	[a] 7,849,027 [b] 256,960	2,321,892 110,525
1908	[a] 5,199,996 [b] 93,085	1,498,822 42,150	[a] 3,147,097 [b] 8,260	880,218 1,719	[a] 8,347,093 [b] 101,705	2,379,040 43,869
1909	[a] 6,441,483 [b] 145,672	1,678,195 71,637	[a] 2,970,388 [b] 106,600	801,436 56,925	[a] 9,411,871 [b] 252,272	2,479,631 128,562
1910	[a] 5,778,660 [b] 131,590	1,841,233 75,906	[a] 3,960,148 [b] 70,655	1,265,287 44,224	[a] 9,738,808 [b] 202,245	3,106,520 120,130
1911	[a] 6,612,988 [b] 53,242	2,171,148 27,842	[a] 2,915,444 [b] 50,914	859,580 45,112	[a] 9,528,442 [b] 104,156	3,030,728 72,954
1912	[a] 7,066,496 [b] 71,124	2,622,648 37,894	[a] 3,375,808 [b] 76,532	824,594 60,629	[a] 10,442,304 [b] 147,656	3,447,242 98,523
1913	[a] 5,737,303 [b] 91,034	2,095,461 50,092	[a] 3,273,369 [b] 67,035	992,286 41,508	[a] 9,010,672 [b] 158,069	3,087,747 91,600
1914	[a] 5,249,651 [b] 83,590	1,920,904 30,384	[a] 2,679,355 [b] 21,860	750,311 17,010	[a] 7,929,006 [b] 105,450	2,671,215 47,394
1915	[a] 6,143,282 [b] 114,547	2,102,814 64,491	[a] 3,948,356 [b] 34,032	830,613 20,253	[a] 10,091,638 [b] 148,579	2,933,427 84,744

[a] Cubic feet. [b] Short tons.

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Bedford oolitic limestone sold in Lawrence and Monroe counties, Ind., in 1914 and 1915.

1914.

County.	Building.						Other uses.[a]		Total value.
	Rough.		Dressed.		Total.				
	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (cubic feet.)	Value.	Quantity (short tons).	Value.	
Lawrence	3,118,470	$692,381	2,131,181	$1,228,523	5,249,651	$1,920,904	83,500	$30,384	$1,951,288
Monroe	1,562,191	279,095	1,117,164	471,216	2,679,355	750,311	21,860	17,010	767,321
	4,680,661	971,476	3,248,345	1,699,739	7,929,006	2,671,215	105,450	47,394	2,718,609
Average price	.....	$0.21	.....	$0.52	.....	$0.34	.....	$0.45	.....

1915.

Lawrence	3,955,350	$804,312	2,187,932	$1,298,502	6,143,282	$2,102,814	114,547	$64,491	$2,167,305
Monroe	2,016,823	202,559	1,931,533	628,054	3,948,356	830,613	34,032	20,253	850,866
	5,972,173	1,006,871	4,119,465	1,926,556	10,091,638	2,933,427	148,579	84,744	3,018,171
Average price	.....	$0.17	.....	$0.47	.....	$0.30	.....	$0.57	.....
Percentage of increase in 1915	27.6	3.6	26.8	13.3	27.2	9.9	40.8	78.8	11.0

[a] Includes stone used for rubble, riprap, curbstone, flagstone, glass making, sugar factories, ground limestone, etc.

According to the first of these tables the maximum value of sales was in 1912, with marked declines of 10 per cent and 14 per cent in the two following years. There was a gain of $299,562 (11 per cent) in 1915 compared to 1914, but this was not enough to raise the value of that year to the figures of any other year since 1909. According to the second table the increase was chiefly in the value of dressed building stone. The gain in quantity of both rough and dressed stone in 1915 was greater than in value owing to decrease in average price per cubic foot. This price for rough stone, which had decreased from 22 cents in 1913 to 21 cents in 1914, dropped to 17 cents in 1915; the average price of dressed stone, which had dropped from 57 cents in 1913 to 52 cents in 1914, was only 47 cents in 1915.

The increase in total quantity and value in 1915, in contrast to the continued decrease in price per cubic foot, reflects conditions in the district as reported by several producers. According to them the building stone industry in Indiana, as well as elsewhere in the country, has not been satisfactory for several years, except in 1912 which is conspicuously above the average. The average price since that year has been so low that several companies have operated at a loss and some have closed their quarries. One company stated that the demand for stone in 1915, "at a living price," was the worst ever experienced, owing not only to the general depression but to ruinous competition for orders that were not sufficient to keep all mills and quarries in operation.

Causes of the present condition of the industry began several years ago. The period preceding the depression of 1907–8, was, as shown in the first of the preceding tables, one of intense and increasing activity. The increase in popularity of stone during this period is

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largely attributed by men thoroughly acquainted with the industry to the promotion of its use by local cut stone contractors, where price, availability, and working qualities permitted. Under these conditions, Indiana limestone, as shown by comparison of the figures of its marketed production with those of other stone, became the most widely used building stone in the country.

During this period great expenditures were made to equip quarries and mills with facilities for meeting the growing demand. Large finishing mills were erected to fill large and difficult orders and to supply cut stone to districts where there were not local plants. These large plants, however, began to acquire quarries in order to control the raw material, mostly at a time when the demand for stone became poor, owing to general business depression in 1907 and 1908. A sales policy was inaugurated by which the local cut-stone contractor was eliminated, and prices, whether for the largest or the smallest contracts, were made sufficiently low to gain the orders, but at a sacrifice of legitimate profits. The cutting plants, as stated by McMillan [1] possess all the unhealthy features of a monopoly, but instead of making large profits, they are neither making money themselves nor permitting others to do so. Mr. McMillan adds that the evil is caused not by the fact that there are some large plants in the district, but rather because there are too many, and in addition to them numerous small ones, which, in order to get business, solicit even the smallest contracts anywhere in the country. Orders for single carloads have been taken from places as far away as British Columbia.

The cutting plants by controlling all the quarry products were able to convert inferior stone into a finished product that appeared acceptable when newly cut. It is said by some producers that inferior stone, together with a lower standard of work, has further decreased the demand and allowed artificial stone to be used in its place.

The cutting plants in the quarry districts have been favored by equal freight rates on cut and rough stone, regardless of their difference in value. The elimination of the local cut-stone contractor, however, although it may lessen the cost of production for a given piece of work, has tended to decrease the demand as a whole, since the largest proportion of building stone produced is for small work, such as steps, lintels, sills, and other trimmings, which can be supplied to advantage only by local contractors. The quantity of Indiana limestone now carried in stock at local stone yards is so small that many orders are lost.

Hope that these unsatisfactory conditions have already begun to improve is founded in part on the general increase in building, which began late in 1915; in part on the organization of stone cutters in an attempt to restrict the shipment of finished stone from quarry districts; also in a tendency on the part of railroads to adjust freight rates equitably to the interests of both the carrier and the local stone trade. McMillan [2] suggests that an adjustment of the work done by cutting plants in quarry districts and elsewhere may be beneficial—that the former should confine themselves primarily to the sawing of stone and to the filling of large contracts for cut stone

[1] McMillan, W. M., address at meeting of International Cut Stone Contractors' and Quarrymen's Association, Atlantic City, N. J., Jan. 19, 1916, pp. 6–7.

[2] Op. cit., p. 6.

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that they alone can handle, whereas the plants remote from quarry districts should take care of all local demands for the finishing of sawed stone.

Carthage district, Mo.—Missouri, which ranked next to Indiana in production of limestone for building, showed a gain in total value of $80,186 (25 per cent) in 1915 compared to 1914, due to a marked increase in value of dressed stone, which more than offset a large decrease in value of rough stone. The gain was made in the Carthage district, which supplied stone for the new State capitol of Missouri.

About 70 per cent of the Missouri building stone sold in 1915, compared with 66 per cent in 1914, was quarried in the Carthage district. The gain in building stone in the Carthage district was 87,904 cubic feet in quantity and $178,405 (86 per cent) in value, and followed decreases in value of $29,970 (12 per cent) in 1914 and $32,406 (12 per cent) in 1913. The value for building stone in the table below includes part of the marble production of Missouri. (See p. 800.) The average price per cubic foot for building stone was 67 cents in 1912, 68 cents in 1913, 74 cents in 1914, and $1.05 in 1915. The comparatively high price in 1915 was due to the large amount of dressed stone furnished for the State capitol. Stone for other use than building represents only a small fraction of the marketed production of this district.

Limestone and marble sold at Carthage, Jasper County, Mo., in 1908–1915.

Year.	Number of producers.	Building stone.		Curbing.	Flagging.	Rubble.	Other.[a]	Total value.
		Quantity (cubic feet).	Value.					
1908	8	431,576	$280,249	$5,238	$3,602	$2,682	$17,826	$309,597
1909	8	481,274	334,715	1,263	6,232	3,791	24,001	370,002
1910	10	502,161	347,244	1,767	7,229	2,945	23,571	382,756
1911	9	427,974	293,470	2,427	2,431	2,596	23,865	324,789
1912	8	404,685	268,930	670	2,878	4,885	28,087	305,450
1913	7	346,421	236,524	.....	2,367	1,500	18,564	258,955
1914	7	280,046	206,554	.....	2,883	1,951	21,426	232,814
1915	7	367,950	384,959	(b)	2,614	[b] 1,220	25,471	414,264

[a] Includes stone used for monumental work, crushed stone, stone sold to glass factories, blast furnaces, sugar factories, etc.
[b] Curbing included in flagging; rubble includes riprap.

Minnesota districts.—Minnesota, which ranked third in value of limestone sold for building, showed a decrease of $45,970, or 28 per cent, in 1915. The most important district where limestone for building is quarried in Minnesota is that of Kasota. Mankato, also, is an important limestone quarry district, but its production of the better grades of building stone is small. It is impossible to give the details of production of these districts without disclosing individual figures for certain kinds of stone.

Bowling Green district, Ky.—Kentucky in 1915 showed a decrease of $7,102 (6 per cent) in value of limestone sold for building. The greater part of Kentucky's production (78 per cent in 1915) comes from the quarries of oolitic limestone near Bowling Green, Warren County. The total value of building stone in this county decreased $8,218 in 1915, owing to a decline in demand for dressed stone. The average prices per cubic foot for rough and dressed stone showed little change. The year 1915 was reported to be the dullest in a period of several years, owing to the general business depression. Customers ordered only for

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immediate use. Most of the quarries were idle a considerable part of the year, and those that were active were either restricted to development work or were filling orders placed before the effects of the depression were generally felt. There was also a marked decline in the demand for crushed stone in Warren County, bringing the total value of stone sold to the lowest figure since the statistics of the county have been published. Notwithstanding this inactivity it is reported that the Bowling Green stone is meeting with increasing favor north and east, especially with landscape architects.

Limestone sold in Warren County, Ky., 1909–1915.

Year.	Rough building.		Dressed building.		Crushed stone.		Other.[a]	Total value.
	Quantity (cubic feet).	Value.	Quantity (cubic feet).	Value.	Quantity (short tons).	Value.		
1909	203,120	$60,936	74,482	$62,989	46,725	$22,013	$33,704	$179,642
1910	204,602	56,141	90,100	57,350	109,183	47,532	5,584	166,607
1911	134,291	45,792	103,220	76,589	57,720	25,921	250	148,552
1912	148,711	51,638	114,308	100,774	38,495	17,563	1,890	171,965
1913	110,576	36,388	95,915	74,250	37,972	20,476	2,045	133,159
1914	104,895	36,043	80,427	60,292	39,906	22,344	.....	118,679
1915	125,112	41,693	60,641	46,424	17,859	8,339	300	96,756
Average price	.....	$0.33	.....	$0.77	.....	$0.47	.....	.....

[a] Curbing, flagging, fluxing, and monumental stone.

Rockwood district, Ala.—No special comments were made by producers in the other more important States, except Alabama. Here the building-stone industry during the greater part of 1915 was only about half as active as in 1914, as it was largely dependent on the cotton trade, which was adversely affected by the European war. A marked increase in sales took place, however, during the closing months of 1915, and the outlook for 1916 is very encouraging. A limestone that has become of increasing importance in recent years is the oolitic stone of Rockwood. There is a well-equipped finishing plant at the quarry, which is favorably situated with respect to the leading southern markets. The following test records indicate that this stone has strength and other properties generally similar to other oolitic limestones of established reputation.

Chemical composition of oolitic limestone, Rockwood, Ala.

[P. C. Bowers, analyst.]

Silica (SiO_2)	0.49
Alumina (Al_2O_3) and iron oxide (Fe_2O_3)	.30
Calcium carbonate ($CaCO_3$)	98.23
Magnesium carbonate ($MgCO_3$)	.97
Moisture and loss on heating to 175° C.	.07
	100.06

Loss of weight on drying for 18 hours at 100° C., 2.3 per cent.

Transverse breaking test of two beams 4.2 inches thick and 4 inches wide with length of span 4 feet: 1,224 and 1,276 pounds per square inch, average 1,250 pounds.

Crushing strength of 3-inch cubes, pressure applied across bedding: 4,136 to 5,758 pounds per square inch, average of four cubes, 4,553 pounds.

Percentage of absorption, 4.4 per cent in 25 hours; 4.53 per cent in 7 days.

Specific gravity (apparent), 2.237; (true), 2.703; weight per cubic foot, 140 pounds.

Density, 82.76 per cent; voids, 17.24 per cent.

Loss due to abrasion of a 4-inch cylinder weighing about 4 pounds placed for 30 minutes on a rubbing table 10 feet in diameter, which revolved at 35 revolutions per minute while clean, sharp sand was fed on it by a stream of water, 15.25 per cent.

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OTHER USES.

Paving blocks.—The value of limestone for paving blocks, which had decreased from $239,340 in 1913 to $114,877 in 1914, fell to $19,396 in 1915. This continued decrease was largely due to Pennsylvania, whose sales were $129,440 in 1913, $70,420 in 1914, and only $1,826 in 1915. Other States with conspicuous, though relatively small, decreases in 1915 were Illinois, Indiana, Maryland, and Missouri. Iowa was the leading State, with an increase from $5 519 to $9,015.

Curbing.—Sales of limestone for curbing, which increased $11,614 in value in 1914, decreased $39,992 in 1915. Indiana, the only State in which limestone sold for curbing attained a conspicuous value, showed a decrease of $20,162 in 1915. The decrease in value was evidently less than that in quantity, as one producer reported an advance in price of 7 cents a foot in Indianapolis as a result of rigid inspection. Wisconsin, which ranked second, showed a decrease of $10,580.

Flagging.—Sales of limestone for flagging in 1915 continued to be very small, but showed an increase of $624. Decreases in Missouri and Wisconsin were offset by an increase in Indiana. The total value for the country has been between $7,000 and $8,000 for the last three years.

Rubble.—Limestone for rubble decreased $117,220 in value in 1915, following decreases in 1914 and 1913. The largest decreases were in Ohio, Illinois, Utah, Iowa, and Kansas. Missouri, the leading State, showed a relatively small increase.

Riprap.—The value of limestone for riprap increased $182,513 in 1915, following a decrease of $208,300 in 1914 and an increase of $148,972 in 1913. Missouri, the leading State, showed a decrease of $158,835, and Texas a decrease of $52,993 in 1915, but these amounts were more than offset by increases in several States, notably Tennessee, Illinois, Kansas, Ohio, and Iowa. The large quantity sold in Texas was for harbor improvement work on the Gulf coast, but shipments for this work were nearly completed in 1915, and the figures for 1916 may be expected to show another large decrease.

Crushed stone.—Crushed stone showed the largest decrease in value of all classes of limestone—$958,886. Crushed stone for all purposes decreased, that for concrete by the greatest amount and that for road metal by the least. For further information on crushed limestone the reader is referred to pages 825–842. It is probable that the figures for crushed limestone for roads include some stone used for concrete, as some producers reported that they could subdivide their total sales only approximately.

Furnace flux.—Limestone for furnace flux in 1915 continued to rank next in value to that for crushed stone. Its great increase in 1915, $1,781,978, followed an even greater decrease in 1914, $3,213,620 and was due to increased activity in the iron and steel industry as a result of the European war. The average price per ton was 51 cents in 1915, compared to 52 cents in 1914, and 49 cents in both 1913 and 1912. That the average price did not advance with increase in demand was largely due to the fact that contracts had been made before June, when the period of activity began. That the great increase in activity was localized is shown by the following comparisons, in the accompanying table. Pennsylvania, by far the leading State in this product, alone showed an increase of $1,235,975,

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and exceeded its large value for 1913 ($4,206,797). Ohio, Michigan, West Virginia, and New York, with values greater than $300,000 all showed increase, but only Michigan equaled its value for 1913. Of the other States with values in excess of $100,000 in 1915, Montana and New Jersey showed increase, but Alabama, Colorado, Utah, and Virginia showed decrease. The price of iron in Virginia was so low during the first half of 1915 that few furnaces were in operation and the demand for limestone was correspondingly low. Producers in Washington complained of foreign competition, and stated that limestone could be imported from British Columbia at less than the cost of domestic production.

Furnace flux sold in the United States in 1914 and 1915.

State.	1914		1915	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Alabama	637,049	$360,691	523,066	$289,167
Arizona	(a)	(a)	1,400	1,330
Arkansas			22	38
California	38,561	43,766	57,991	70,087
Colorado	462,660	277,355	453,865	272,093
Connecticut	(a)	(a)	2,675	1,675
Georgia	3,419	2,722	3,741	3,453
Illinois	744 270	283,398	873,095	348,547
Indiana	183,645	85,047	139,473	69,334
Iowa	1,800	1,200	3,794	2 905
Kansas	540	455	697	533
Kentucky	33,845	21,287	29 969	19,259
Maryland	2,108	1,380	4,332	2,059
Michigan	1,432,357	565,012	2,254,984	763,029
Minnesota	180	180	564	664
Missouri	31,666	29,866	28,908	26,591
Montana	528,675	158,801	623,216	189,576
Nebraska	12,000	9,000		
New Jersey	286,826	136,038	298,303	141,915
New York	698,382	407,543	732,181	416,712
North Carolina	15,701	10,552	24,000	17,000
Ohio	2,110,665	1,042,754	2,698,321	1,321,921
Oklahoma	718	630		
Pennsylvania	6,467,961	3,563,571	8,625,636	4,799,546
Rhode Island	(a)	(a)	(a)	(a)
Tennessee	114,738	62,893	88,823	49,545
Texas	45,679	30,780	37,499	25,280
Utah	353,920	235,487	248,181	158,691
Vermont	400	400	253	254
Virginia	229,000	134,287	200,465	126,623
Washington			25	19
West Virginia	806,451	391,017	976,044	518,827
Wisconsin	49,344	28,341	66,332	33,696
Other States	6,196	5,916	868	1,478
	15,298,756	7,890,369	18,998,723	9,672,347
Average price per ton		$0.52		$0.51
Per cent of increase			24.2	22.6

a Included in "Other States."

Sugar refineries.—Limestone sold to sugar refineries in 1915 showed an increase in value of $57,242 over that sold in 1914. Its value, however, was $6,686 less than that for 1913, which was the record value. These values represent only a part of the total quantity of limestone quarried for sugar refineries, as a number of refiners quarry and burn their own stone, and report their output as lime, which is included in the chapter on lime. The total value of lime and limestone for sugar refineries in 1915 was $611,406, an increase of $100,005 over the value in 1914 and of $6,914 over that of 1913. In fact 1915 appears to have marked a revival of this industry which as a whole had been declining.

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Fertilizer.—Pulverized, unburned limestone is applied to the soil for fertilizer, or soil sweetener. The quantity and value of this product in 1915 was far greater than in any other year. The proportion of increase has grown greater each year as shown in the following table:

Pulverized limestone sold as fertilizer in the United States in 1911–1915.

Year.	Quantity (short tons).	Value.
1911	174,290	$205,006
1912	200,000	311,702
1913	408,627	493,718
1914	615,197	688,961
1915	810,399	893,530

Sales of burned lime for fertilizer also increased in both 1914 and 1915, still further indicating the growing appreciation throughout a large part of the country of the value of limestone and burned lime as fertilizers. As a result pulverized limestone has become a by-product of several limestone and marble quarries. It is a striking fact, as noted in the chapter on lime, that the States from which no limestone for fertilizer is reported are mostly in semiarid regions where only irrigation is necessary to render the soil fertile, or in regions so newly opened to agriculture that the soils do not yet require lime. Three States—Massachusetts, South Carolina, and Louisiana—which are exceptions to the rule, yield very little limestone, and the limestone quarries are not readily accessible to a large part of the farming area. In all the three States the demand in 1915 was supplied by burned lime.

Difference of opinion continues to exist as to the relative merits of limestone and burned lime in agriculture, and producers state that the demand for one or the other has fluctuated as a result of publicity work by advocates of one product or the other. In 1915 it was reported from one district that although pulverized limestone increased, there were indications of a growing demand for hydrated lime, which was expected largely to displace pulverized limestone within a few years. From another district it was reported that the quantity of pulverized limestone was increasing and would probably continue to increase.

Miscellaneous uses.—The column headed "Other" in the table on page 807 is in part itemized as follows for limestone:

Limestone used for special purposes in 1915.

Use.	Quantity (short tons).	Value.
Alkali works	1,621,662	$765,828
Glass factories	148,638	129,920
Paper mills	52,262	40,586
Carbonic-acid plants	206,552	61,028
Lime burners	115,088	75,656
Miscellaneous [a]		331,414
		1,404,434

[a] Includes limestone sold for crushing; for putty, paint, and asphalt filler; for mineral wool, whiting, ammonia, basic magnesium carbonate, and other chemical uses.

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Limestone for alkali works represents more than half the total. Limestone sold to lime burners as shown by comparison with the table on page 805 was produced mainly in Ohio, Pennsylvania, and Virginia, and its value in 1915 decreased $9,236. It forms only an insignificant part of the quantity of limestone annually burned into lime. Limestone for paper mills showed a decrease in value of $8,576 in 1915, and burned lime for the same use showed a decrease of $132,973. Figures showing the value for other minor uses in 1914 are not available.

LITHOGRAPHIC STONE.

No domestic production of lithographic stone was reported for 1915, although developments at Brandenburg, Ky., during that year were encouraging, and small quantities of stone may have been sold in Louisville. A number of small samples of stone from various places have been received by the Survey with requests to determine their qualities for lithographic work. Tests of some of these samples have given promising results, but all the samples have been far too small to be given a fair trial. An adequate sample must be at least 12 inches square and 2 inches thick, and must be polished on both sides.

Imports of lithographic stone valued at $8,870 were reported for 1915. This small value, together with that of imports in 1914 ($46,043), should have given a particularly favorable opportunity for the marketing of domestic lithographic stone; but not only was no production reported, but no inquiries from buyers have been received.

According to some of the leading lithographers of the United States there is still available a good supply of Bavarian stone in small sizes. A few state that they have had no trouble in procuring the larger sizes as well, but others say that there is practically no first-class stone in sizes from 28 by 40 to 44 by 64 inches, and that there is likely to be urgent need of them unless imports are soon received. Many lithographers with an accumulation of small stones on hand are said to be erasing old engravings and using the same stone repeatedly. The supply of unused stone now available is what has been picked over a number of times. It is understood that shipments of stone are ready to leave certain European ports as soon as the blockade is lifted. Prices on lithographic stone have increased considerably above the average that existed before the war but are remarkably low under the circumstances.

The introduction during the last 12 to 15 years of zinc and aluminum plates and the rubber offset process into lithography has largely supplanted the use of stone for some kinds of work. Some lithographers state that these substitutes yield as good results, that the demand for large sizes of stone in particular has decreased in consequence, and that by the time a domestic lithographic stone of superior quality is definitely put on the market the demand for it will be very slight. Others state that the substitutes have not given as good results as stone for work of the highest grade but have tended rather to develop new lines of work than to displace stone entirely, and that in spite of these processes the use of stone will therefore continue in slightly diminished quantity, as there will

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be a considerable range of work that must be done on stone to give entire satisfaction. This is especially true in printing maps where hard papers are specified, for "originals," half tones, and other fine grades of work. It is said that, whereas posters are now printed from zinc plates on rotary lithographic presses, many poster lithographers printing in small editions use stone exclusively.

Among the conditions with which domestic producers must contend when conditions are normal are the following: The higher cost of labor in America than in Europe; the cost of railroad transportation from interior States to New York[1] and other eastern cities, which may equal or exceed ocean freight charges from Europe; and the fact that the Bavarian stone occurs in layers only 3, 4, or 5 inches in thickness and requires only planing and polishing, whereas prospective lithographic stones that are known in the United States occur in relatively thick beds and must first be sawed to desired thicknesses, thus doubling the labor needed by the Bavarian stone. For these reasons it is asserted by at least one importer that the Bavarian stone, under normal industrial conditions, can undersell any domestic lithographic stone. Another reason said to have an influence against the domestic producer is that lithographers are so well used to handling the Bavarian stone that they prefer it to an American stone which, though well adapted for lithography, may be of a different degree of hardness, and with which they must become thoroughly familiar before they can obtain good results.

As is commonly known, there are two varieties of Bavarian stone—the blue and the yellow. It is said that there are only two quarries of the blue stone, which is of superior quality, and that customers have to pay whatever price is asked for it. This variety has usually sold in New York at 5 to 6 cents a pound for 10 by 12 inch slabs. Only the blue variety is satisfactory for work of the highest grade. The yellow stone, of relatively inferior quality, is produced from a great number of quarries and 10 by 12 inch slabs have usually sold in New York for 1½ cents a pound.

[1] New York, the principal market, is said to consume 40 to 45 per cent of the total quantity sold.

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SANDSTONE.

General statistics.—The value of the sandstone sold, which, after an almost steady decline from 1903 to 1912, increased in 1913 and 1914, underwent a marked decrease in 1915. The value in that year, as shown in the table below, was $1,406,008, or 19 per cent less than in 1914, and was less than in any year since 1899. Ohio, Pennsylvania, and New York, in the order named, were the leading States in production in 1915, Pennsylvania regaining second place from New York, which was second in 1914. Pennsylvania was the only one of these States to show an increase in value—$113,812. Other noteworthy increases were in California, $58,972, and Virginia, $28,306. Ohio's decrease was $112,463, and New York's $474,708. Other States with decrease of over $100,000 were Washington, Alabama, Texas, and New Mexico.

According to the table on pages 820–822, the decline in 1915 was general except for ganister and rubble, which showed gains approximating $50,000. The principal losses were in building stone, riprap, and "other uses."

Value of sandstone (including quartzite and bluestone) produced and sold in the United States, 1911–1915.

State.	1911	1912	1913	1914	1915
Alabama	$73,195	$27,596	$151,111	$161,773	$30,432
Arizona	[a] 57,100	21,524	88,391	23,760	9,625
Arkansas	85,529	80,538	89,395	79,358	54,747
California	176,213	70,724	139,486	277,657	336,629
Colorado	135,673	108,169	96,964	97,029	52,487
Connecticut	(a)	(b)	(b)	(b)	(b)
Florida	(a)	(b)	(b)	.....	.....
Georgia	.....	(b)	(b)	.....	.....
Idaho	40,097	13,883	20,111	22,837	10,302
Illinois	30,953	32,720	28,781	72,738	43,307
Indiana	7,078	(b)	(b)	(b)	(b)
Iowa	56,312	1,551	1,612	1,319	(b)
Kansas	13,774	6,031	1,602	2,274	(b)
Kentucky	97,439	114,550	81,171	60,926	70,164
Maryland	10,097	15,950	16,435	8,128	11,038
Massachusetts	[a] 406,072	307,838	404,817	428,926	353,662
Michigan	12,985	16,438	19,224	(b)	(b)
Minnesota	292,366	349,063	315,149	210,099	173,995
Missouri	19,748	15,004	10,195	3,588	10,104
Montana	34,437	33,280	51,081	(b)	6,346
Nebraska	(a)	(b)	(b)	(b)	(b)
New Jersey	155,765	166,583	69,584	53,394	63,964
New Mexico	4,085	(b)	66,700	412,845	296,809
New York	[c] 2,353,995	[c] 1,651,317	[c] 1,568,952	[c] 1,475,231	[c] 1,000,523
North Carolina	[a] 10,385	(b)	(b)	(b)	27,544
Ohio	1,334,947	1,312,300	1,316,028	1,523,796	1,411,333
Oklahoma	90,971	5,334	1,010	1,934	2,525
Oregon	[a] 1,668	.....	(b)	(b)	(b)
Pennsylvania	[c] 1,333,309	[c] 1,367,601	[c] 1,359,533	[c] 1,140,182	1,253,994
South Dakota	141,615	139,167	163,165	126,413	119,225
Tennessee	(a)	(b)	(b)	(b)	(b)
Texas	28,000	82,501	58,750	197,800	73,128
Utah	41,953	32,562	23,965	67,578	27,267
Virginia	31,315	4,020	(b)	150,469	178,775
Washington	301,843	344,476	500,468	450,436	(b)
West Virginia	203,935	183,410	146,998	142,459	124,929
Wisconsin	144,430	179,352	213,229	167,595	180,198
Wyoming	3,584	3,730	(b)	11,831	10,840
Other States	.....	206,299	185,358	129,433	141,908
	7,730,868	6,893,611	7,248,965	7,501,808	6,095,800

[a] Arizona includes Florida; Massachusetts includes Connecticut: Oregon includes Nebraska; North Carolina includes Tennessee.
[b] Included in "Other States."
[c] Includes bluestone.

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Value of sandstone (including quartzite and bluestone) sold in the United States in 1914 and 1915.

1914.

State.	Rough building.	Dressed building.	Ganister.	Paving.	Curbing.	Flagging.	Rubble.
Alabama	$57,079		$2,300				$1,558
Arizona	10,050						10
Arkansas	375	$177			$3,539	$203	250
California	2,502	21,414					502
Colorado	8,085	13,428	8,267	$38,487	4,762	2,357	3,795
Idaho	16,291	6,330					125
Illinois	525		1,563				
Iowa	453						80
Kansas	960	241			50	349	674
Kentucky	3,277	55,407					
Maryland	1,000		2,008				2,720
Massachusetts	62,973	17,894					920
Minnesota	3,221	59,522		100,071	8,340		4,738
Missouri	695	1,964					600
New Jersey	29,794	200		325	275	300	
New Mexico	208	137					1,200
New York	53,461	176,116		361,850	375,601	112,014	1,989
Ohio	113,193	452,198	725	19,175	478,574	354,475	19,522
Oklahoma	326						
Pennsylvania	222,122	176,083	239,211	44,105	113,147	48,963	44,689
South Dakota	10,153	15,379		24,680			545
Texas				8,000	2,000		3,000
Utah	2,709			60,786		1,240	1,043
Virginia							135
Washington	2,372	15,674		13,213			283
West Virginia	9,315	66,147		6,000	1,854	11	5,700
Wisconsin	19,891	35,481	34,170	37,000			6,861
Wyoming	272						
Other States	67,007	13,078			175	45	4,987
	608,309	1,126,870	288,244	713,692	988,317	519,957	105,906

State.	Riprap.	Crushed stone.			Other.	Total value.
		Road metal.	Railroad ballast.	Concrete.		
Alabama	$15,694			$85,142		$161,773
Arizona		$4,000		600	$9,100	23,760
Arkansas	35,077	5,302	$18,104	16,331		79,358
California	22,408	154,596	7,945	66,672	1,618	277,657
Colorado	9,546	1,500	700	2,500	3,602	97,029
Connecticut						(a)
Idaho					91	22,837
Illinois		65,026	5,615		9	72,738
Indiana						(a)
Iowa	96				690	1,319
Kansas						2,274
Kentucky	2,242					60,926
Maryland		2,400				8,128
Massachusetts		104,625	3	242,511		428,926
Michigan						(a)
Minnesota	128			23,804	10,275	210,009
Missouri	16				313	3,583
Montana						(a)
Nebraska						(a)
New Jersey	950	16,500		4,250	800	53,394
New Mexico	1,800			315,000	94,500	412,845
New York	6,227	64,499	2,659	111,597	209,218	1,475,231
North Carolina						(a)
Ohio	80,155	1,675	1,000	3,089	15	1,523,796
Oklahoma				1,600	8	1,934
Oregon						(a)
Pennsylvania	9,131	93,595	55,729	86,526	6,881	1,140,182
South Dakota	13,432	2,500		59,724		126,413
Tennessee						(a)
Texas	149,500	2,000	800	32,500		197,800
Utah					1,800	67,578
Virginia	200	136,500	9,422	4,062	150	150,469
Washington	418,914					450,436
West Virginia	19,892	5,035	14,418	14,037	50	142,459
Wisconsin	2,181	21,700		10,300	11	167,595
Wyoming	919			10,640		11,831
Other States	24,952		1,672	8,100	9,417	129,533
	813,460	681,453	118,067	1,098,985	348,548	7,501,808

a Included in "Other States."

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Value of sandstone (including quartzite and bluestone) produced and sold in the United States in 1914 and 1915—Continued.

1915.

State.	Rough building.	Dressed building.	Ganister.	Paving.	Curbing.	Flagging.	Rubble.
Alabama	$150	.....	$4,500	.....	.....	.....	$13,327
Arizona	125	.....	.....	.....	.....	.....	.....
Arkansas	388	.....	.....	$8,505	.....	.....	.....
California	2,800	.....	.....	.....	.....	.....	9,057
Colorado	3,230	$1,277	7,827	12,060	$3,274	$819	2,056
Connecticut	(a)	(a)	.....	.....	.....	.....	(a)
Idaho	4,959	4,931	.....	.....	.....	.....	288
Illinois	306	.....	1,500	.....	.....	.....	100
Indiana	(a)	.....	.....	.....	.....	.....	.....
Iowa	(a)	.....	.....	.....	.....	.....	(a)
Kansas	(a)	.....	.....	.....	.....	.....	(a)
Kentucky	2,205	57,779	.....	.....	.....	.....	600
Maryland	2,175	.....	3,208	.....	.....	.....	2,632
Massachusetts	35,290	5,030	.....	.....	.....	.....	17,370
Michigan	(a)	(a)	.....	.....	.....	.....	(a)
Minnesota	430	40,654	.....	38,771	25,241	.....	5,291
Missouri	1,124	5,944	.....	.....	.....	.....	694
Montana	40	4,125	.....	.....	.....	.....	1,731
Nebraska	(a)	.....	.....	.....	.....	.....	.....
New Jersey	33,255	13,726	.....	325	275	300	.....
New Mexico	900	60	.....	.....	20	.....	38,185
New York	35,790	170,985	.....	259,923	269,787	70,165	128
North Carolina	.....	1,100	.....	.....	.....	.....	.....
Ohio	66,759	401,980	1,600	.....	492,588	340,846	6,556
Oklahoma	3	.....	.....	.....	.....	.....	.....
Oregon	(a)	.....	.....	.....	.....	.....	.....
Pennsylvania	139,991	182,674	276,505	113,133	97,067	57,533	29,778
South Dakota	2,948	15,983	545	3,780	.....	6	2,481
Tennessee	.....	.....	(a)	.....	.....	.....	.....
Texas a	.....	.....	.....	.....	.....	.....	.....
Utah	272	.....	.....	26,987	.....	.....	8
Virginia	.....	.....	.....	.....	.....	.....	300
Washington	.....	(a)	(a)	(a)	.....	.....	.....
West Virginia	3,588	30,898	.....	100	2,212	108	6,943
Wisconsin	9,340	23,498	40,082	55,492	.....	.....	9,116
Wyoming	2,380	.....	.....	.....	.....	.....	300
Other States	83,744	24,006	500	13,704	.....	.....	9,247
	432,192	984,650	336,267	532,780	890,464	469,777	157,088

a Included in "Other States."

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Value of sandstone (including quartzite and bluestone) produced and sold in the United States in 1914 and 1915—Continued.

1915—Continued.

State.	Riprap.	Crushed stone.			Other.	Total value.
		Road metal.	Railroad ballast.	Concrete.		
Alabama	$12,455					$30,432
Arizona				$2,000	$7,500	9,625
Arkansas	11,003	$15,000	$17,400	2,451		54,747
California	74,742	109,632	26,924	107,368	5,206	336,629
Colorado	4,914	3,100	2,200	10,000	1,730	52,487
Connecticut	(a)				(a)	(a)
Idaho	124					10,302
Illinois		41,313		88		43,307
Indiana	(a)					(a)
Iowa		(a)		(a)		(a)
Kansas						(a)
Kentucky	8,880			300	400	70,164
Maryland	323	2,700				11,033
Massachusetts		72,975		222,997		353,662
Michigan	(a)					(a)
Minnesota	1,990	26,223		29,840	5,555	173,995
Missouri	2,342					10,104
Montana	450					6,346
Nebraska						(a)
New Jersey	1,200	9,000		4,933	950	63,983
New Mexico	34,287	407		222,950		296,804
New York	4,831	65,866	14,735	84,519	23,794	1,000,529
North Carolina		5,220	13,261	5,963	2,000	27,543
Ohio	58,358	20,509		15,752	6,385	1,411,334
Oklahoma				2,500	22	2,525
Oregon						(a)
Pennsylvania	35,942	115,309	84,781	113,608	27,673	1,273,994
South Dakota	9,059	1,952		82,471		119,225
Tennessee						(a)
Texas	60,128	10,000	3,000			73,128
Utah						27,267
Virginia		160,600	10,604	7,271		178,775
Washington	(a)					(a)
West Virginia	17,538	14,336	31,664	17,538	4	124,929
Wisconsin	13,352	16,767	1,200	11,351		180,198
Wyoming				8,160		10,840
Other States	10,232	82		258	135	141,906
	362,150	690,991	205,769	952,318	81,354	6,095,800

a Included in "Other States."

Building stone.—Building stone up to 1913 was the largest product of the sandstone industry, but during 1914 and 1915 it has been exceeded by crushed stone. Building stone, after a decrease of $49,120, or 3 per cent, in 1914, declined $408,337, or 22 per cent, in 1915. About two-thirds of this decrease was in the value of rough stone. Ohio, Pennsylvania, and New York, as usual, were the three leading States, and the only ones whose sales exceeded $100,000 in value. All these three States showed decrease in 1915, and very few States showed increase.

The industry, like that of other kinds of building stone, was affected by the general depression which prevailed in the stone industry until the last three months of the year, when some producers reported enough work in sight to assure a successful year in 1916. In Pennsylvania rainy weather in July and August and labor shortage caused by the departure of Italian laborers for the European war were also reported. Competition with artificial stone has also been reported as a cause of restricted sandstone sales in recent years. Minnesota's relatively large decrease was attributed to decline in Canadian de-

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mand on account of the European war; also to unfavorable competition with softer stone.

The only new development reported in sandstone for building was a plan for opening a quarry of light-gray sandstone, probably of lower Carboniferous (Mississippian) age, on Bear River 3 miles south of Tishomingo, Miss., on the Illinois Central Railroad. The stratum to be worked is reported to be about 25 feet thick and to be favorably situated for quarrying and shipping. Samples sent to the Survey consist of practically pure quartz grains in a siliceous matrix. Tests by Robert W. Hunt & Co. reported by Thomas Wellford & Sons, Memphis, Tenn., gave the following results:

Water test—percentage of absorption by weight after 48 hours immersion, 4.11.
Frost test—yielded no apparent signs of checking or disintegration.
Fire test—after exposure to a temperature of 2,400° F. for a period of half an hour, the sample softened but did not disintegrate.
Specific gravity, 2.422.
Crushing strength of two 3-inch cubes—11,000 and 14,560 pounds per square inch; average, 12,790 pounds per square inch.

Besides giving promise as a building stone, this sandstone is probably suitable for the manufacture of grindstones and similar abrasives.

Ganister.—Ganister increased $48,023 in 1915 after a decrease of $88,531 in 1914. These changes were common to all products used in the iron and steel industry. Pennsylvania, as usual, was by far the leading State, and showed a gain of $37,294 in 1915.

Paving.—Sandstone for paving, which decreased $23,075 in 1914, declined $180,912 further in 1915. New York, the leading State, showed a decrease of $101,927, but Pennsylvania, the second in rank, had a gain of $69,028. Minnesota, second in 1914, decreased $61,300, and fell to fourth place in 1915. The decrease was attributed in part to competition with wood paving blocks and to decline in Canadian demand.

Curbing.—Sandstone for curbing, which decreased $166,519 in 1914, showed a further decrease of $97,853 in 1915. Ohio, the leading State for the last two years, showed an increase of $14,014, which was attributed, in part at least, to publicity work by producers who thereby won contracts in competition with other materials. New York, however, which lost the lead in 1914 showed a further decrease of $105,814, and the value in Pennsylvania, the third State, decreased $16,080. Most of the sandstone for curbing in New York and Pennsylvania was bluestone.

Flagging.—Sandstone for flagging decreased steadily in value during 1913, 1914, and 1915—$167,940 in the first year, $33,172 in the second, and $50,180 in the third. Ohio, the leading State, showed a decrease of $13,629 in 1915, although one company reported a successful year. New York, the second State, showed a decrease of $41,849, and its total value for the first time in many years was below $100,000. Pennsylvania, the third State, showed an increase but of less amount. Practically all the flagging sold in New York and Pennsylvania in 1915 was bluestone.

Rubble and riprap.—Rubble, after a decrease of $94,916 in 1914, made a gain of $51,182 in 1915. New Mexico made the greatest gain. New Mexico and Pennsylvania were the only States with values in excess of $20,000. Riprap, however, after a slight gain in 1914, showed a larger decrease ($451,310) in 1915 than any other class of

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sandstone. This decrease was largely due to the completion of breakwater work in Washington and to less use of sandstone for riprap at Galveston. Conspicuous gains were made in California, where the stone was used in harbor improvement work; in New Mexico, where the Elephant Butte dam was in process of construction; and in Pennsylvania.

Crushed stone.—Crushed sandstone, after considerable increases in 1913 and 1914, showed a decrease of $49,427 in 1915. The decrease was due wholly to a decline in the value of sandstone for concrete, which exceeded the combined increase for road metal and railroad ballast. Further attention is given to crushed sandstone on pages 825–842.

Other uses.—The marked decrease ($267,194) in value of stone for other uses was chiefly due to less stone of miscellaneous character used in construction of dams and waterworks.

BLUESTONE.

The figures of production for bluestone, most of which is quarried in southeastern New York and northeastern Pennsylvania, are included in those of sandstone, but on account of the local importance of the material, the value is also given separately. This stone is marketed under peculiar conditions. Almost all the owners of land in this district have small deposits of the stone on their property and quarry small quantities of it annually, which they sell to agents of large dealers who market the stone. As many of these dealers also quarry the stone, it has been found that the best figures of production are obtained from the dealers, who are better able than the small producers to give the entire quantity of stone bought and sold. The stone is used chiefly for flagging, for curbing, and for sills, lintels, steps, and house copings. In recent years, however, much of this stone for these purposes has been replaced by cement concrete, and decrease in its value has been continuous for four years, as shown in the first of the following tables. For the last few years some of this stone has been crushed and used in the concrete work of the New York City water-supply system, but this work is now completed, and the production of bluestone has correspondingly decreased. The value in 1915 was the smallest recorded since statistics have been collected by the Survey.

Value of bluestone produced and sold in the United States, 1908–1915.

Year.	Value.	Year.	Value.
1908	$1,762,880	1912	$1,505,763
1909	1,446,402	1913	1,290,852
1910	1,535,187	1914	1,086,609
1911	1,876,473	1915	641,446

Decrease in value of the stone sold for different uses is shown in the second table. The principal decrease was in curbing and in "other uses," which included a large quantity of stone used in construction of dams and waterworks.

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Value of bluestone produced and sold in New York and Pennsylvania in 1914 and 1915.

1914.

State.	Building purposes.	Flagging.	Curbing.	Crushed stone.	Other purposes.	Total value.
New York	$190,084	$111,394	$231,590	$161,522	$206,336	$900,926
Pennsylvania	49,078	48,239	67,590	14,738	6,128	185,773
	239,162	159,633	299,180	176,260	212,464	1,086,699

1915.

New York	$170,316	$99,862	$112,184	$104,278	$21,892	$478,532
Pennsylvania	43,082	57,455	54,923	4,452	3,002	162,914
	208,398	112,317	152,107	108,730	24,894	641,446

The bluestone trade, like other branches of the stone industry, is said to have suffered through lack of organization and cooperation on the part of producers and lack of insistence on the use of only first-class material where such material alone could give satisfaction. Evident carelessness in the use of the stone has resulted in uneven curbing and flagging, very inferior to artificial stone in appearance, though better adapted to resist wear.

With the introduction, mostly during the last five or six years, of pneumatic tools and other modern machinery for dressing bluestone, smooth surfaces and sharp edges are readily obtained, and there is no apparent reason why well-selected bluestone should not give as pleasing an appearance as curbing and flagging of any other material. Bluestone varies in quality in different places and even in different beds in a single quarry. Some beds of inferior quality contain shaly partings or lines of weakness that induce scaling on prolonged exposure, and such stone is relatively subject to abrasion; but the more massive beds have been proved by long usage to be highly resistant both to weathering and to abrasion, and to possess crushing and transverse-breaking strengths equal or even superior to the strongest kinds of stone. Although the cost of quarrying and finishing bluestone may prevent its general use, the durability of the stone under the most severe conditions of wear especially recommends it for use in districts where traffic is excessively heavy.

CRUSHED STONE.

MARKETED PRODUCTION.

Crushed stone is the largest factor in the stone industry at the present time. In 1898 the figures for the value of crushed stone were first published; the amount was $4,031,445. Crushed stone, chiefly for road metal and railroad ballast, was reported previously to that time, but was not separated from other products. The growth of the crushed-stone industry is well shown in the following table and in figures 26 and 27, which show the output of exterior building stone, monumental stone, and crushed stone from 1898 to 1915.

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Value of exterior building stone, monumental stone, and crushed stone sold in the United States, 1898–1915.

Year.	Monumental stone (rough and dressed).	Building stone (rough and dressed).	Crushed stone.	Year.	Monumental stone (rough and dressed).	Building stone (rough and dressed).	Crushed stone.
1898....	$3,076,340	$13,014,596	$4,031,445	1907....	$6,978,949	$16,675,811	$22,054,207
1899....	3,338,122	15,732,425	4,692,343	1908....	6,948,841	16,040,630	20,262,012
1900....	3,618,316	15,578,009	6,525,368	1909....	6,104,190	17,594,455	24,078,780
1901....	4,734,699	17,588,102	8,560,432	1910....	6,887,542	16,105,856	27,264,535
1902....	5,941,585	20,790,341	11,480,959	1911....	6,985,416	16,443,758	28,426,375
1903....	5,767,360	19,795,491	13,188,938	1912....	6,759,119	16,306,659	28,502,536
1904....	5,991,714	18,883,455	15,530,122	1913....	7,212,648	14,937,214	31,677,871
1905....	6,112,585	20,240,809	16,419,614	1914....	7,150,293	14,396,528	30,161,766
1906....	6,773,478	20,681,625	17,467,486	1915....	6,747,439	12,248,218	29,173,488
Percentage of decrease in 1915					5.6	14.9	3.4

Crushed stone produced and sold in the United States in 1914 and 1915, by kinds of stone.

1914.

Kind.	Road metal.		Railroad ballast.		Concrete.		Total.		Average price per ton.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	
Granite.....	2,249,494	$1,567,374	852,181	$549,626	2,114,758	$1,858,575	5,216,433	$3,975,575	$0.76
Basalt and related rocks (trap rock)..	3,844,039	2,780,022	2,322,958	1,473,367	2,860,131	1,972,416	9,027,128	6,225,805	.69
Limestone.....	14,763,318	8,300,516	8,493,830	3,967,348	9,410,193	5,794,017	32,667,341	18,061,881	.55
Sandstone.....	929,982	681,453	235,710	118,067	1,287,882	1,098,985	2,453,574	1,898,505	.77
	21,786,833	13,329,365	11,904,679	6,108,408	15,672,964	10,723,993	49,364,476	30,161,766	.....
Average price per ton.....	.....	$0.61	.....	$0.51	.....	$0.68	.....	$0.61	.....

1915.

Granite.....	2,299,046	$1,664,218	1,197,437	$693,996	1,742,718	$1,465,560	5,239,201	$3,823,774	$0.73
Basalt and related rocks (trap rock)..	4,790,092	3,216,107	1,947,715	1,194,873	3,084,030	1,986,661	9,771,837	6,397,641	.65
Limestone.....	14,608,471	8,164,230	7,884,323	3,604,256	9,082,914	5,334,509	31,575,708	17,102,995	.54
Sandstone.....	1,012,461	690,991	338,566	205,769	1,070,934	952,318	2,421,961	1,849,078	.76
	22,710,070	13,735,546	11,368,041	5,698,894	14,930,596	9,739,048	49,008,707	29,173,488	.....
Average price per ton.....	.....	$0.60	.....	$0.50	.....	$0.65	.....	$0.60	.....
Percentage of increase or decrease in 1915.....	+4.2	+3.0	−4.5	−6.7	−4.7	−9.2	−0.7	−3.3	.....

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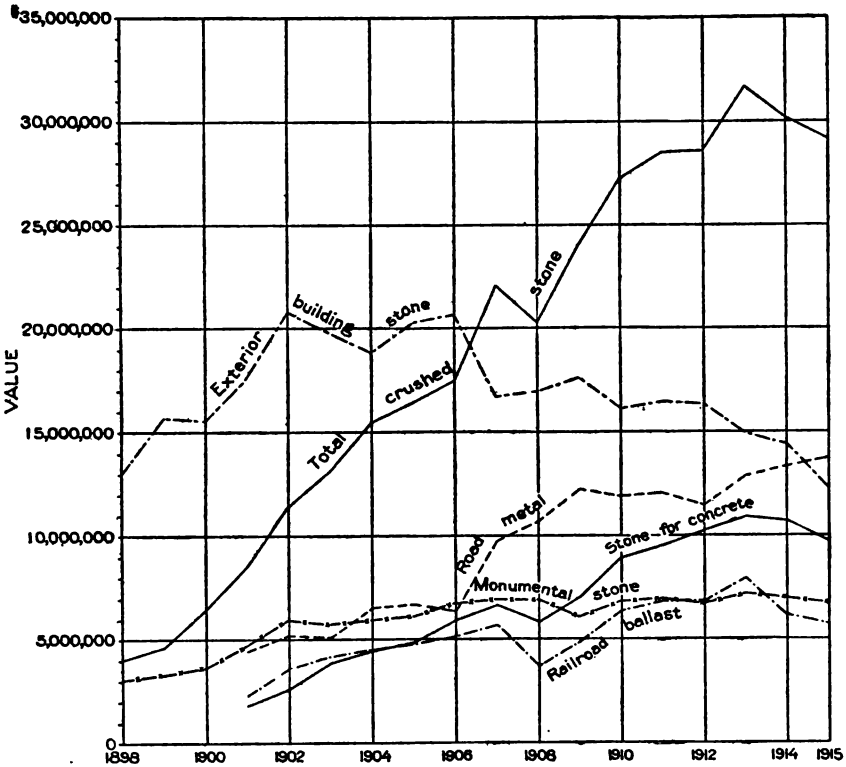

FIGURE 26.—Diagram comparing value of crushed stone with those of stone for exterior building and for monumental work; also showing value of crushed stone for different uses, 1898 to 1915, inclusive.

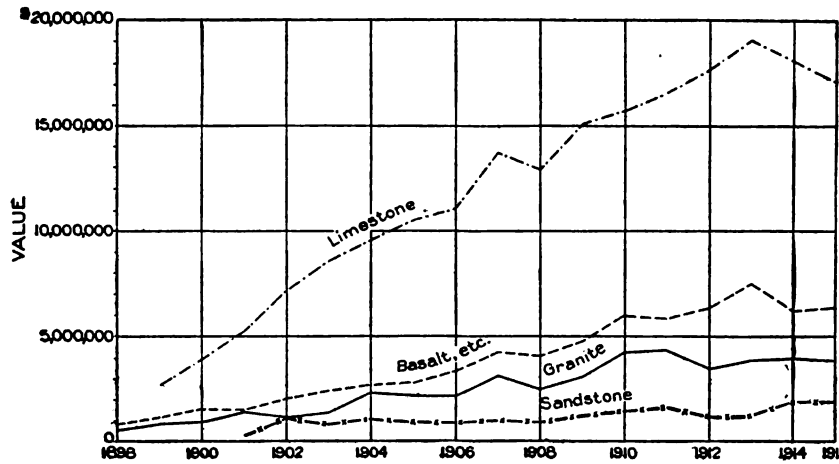

FIGURE 27.—Diagram showing values of limestone, basalt, granite, and sandstone sold as crushed stone, 1898 to 1915, inclusive.

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Crushed stone sold in the United States in 1914 and 1915, by States and Territories.

1914.

State or Territory.	Road metal.		Railroad ballast.		Concrete.		Total.	
	Quantity (short tons)	Value.	Quantity (short tons)	Value.	Quantity (short tons)	Value.	Quantity (short tons)	Value.
Alabama	74,914	$75,528	1,341	$1,076	420,369	$372,261	496,624	$448,865
Arizona	2,600	4,000	.....	.....	2,484	1,961	5,084	5,961
Arkansas	199,417	140,442	79,277	55,536	87,700	63,895	366,394	259,873
California	1,707,230	982,321	598,057	317,733	1,403,178	936,705	3,708,465	2,236,759
Colorado	6,052	10,100	1,000	700	7,802	11,100	14,854	21,900
Connecticut	360,443	216,064	97,295	63,682	421,962	256,903	879,700	536,649
Delaware	53,430	33,501	8,500	5,950	42,885	40,932	86,815	80,383
Florida	159,524	84,911	158,428	82,596	64,680	90,986	382,632	258,493
Georgia	57,553	37,088	34,593	35,039	149,393	121,950	241,539	194,077
Hawaii	41,832	37,049	22,552	17,820	34,708	32,011	99,092	86,880
Idaho	.....	.....	9,000	5,760	.....	.....	9,000	5,760
Illinois	1,838,599	893,889	906,346	378,458	1,914,120	928,827	4,659,065	2,201,174
Indiana	2,089,103	1,065,360	181,849	69,089	83,426	43,767	2,354,378	1,178,216
Iowa	19,308	17,438	255,553	97,747	463,126	278,071	737,987	393,256
Kansas	27,248	20,135	560,013	274,000	296,813	222,302	884,074	516,437
Kentucky	545,878	323,075	1,472,254	615,621	104,166	56,739	2,122,298	995,435
Louisiana	.....	.....	14,760	11,070	45,604	34,203	60,364	45,273
Maine	5,950	4,650	9,709	6,667	12,841	9,781	28,500	21,098
Maryland	404,523	349,833	293,076	195,373	307,547	285,779	1,005,146	830,985
Massachusetts	649,144	594,666	151,274	76,470	622,425	519,167	1,422,843	1,190,303
Michigan	530,823	267,702	42,448	25,372	366,657	171,730	939,828	464,804
Minnesota	46,944	46,172	10,000	7,500	365,647	307,118	422,591	360,790
Missouri	466,143	363,302	218,895	137,428	775,621	622,305	1,460,659	1,123,035
Montana	4,590	1,271	258	56	90,842	36,521	95,690	37,848
Nebraska	32,137	27,300	4,776	2,626	239,208	216,189	276,121	246,115
New Hampshire	20,936	13,745	.....	.....	5,508	4,266	26,444	18,011
New Jersey	827,705	674,202	370,949	253,504	396,422	308,752	1,595,076	1,236,458
New Mexico	.....	.....	.....	.....	326,025	315,000	326,025	315,000
New York	2,267,264	1,408,490	1,574,107	916,952	2,164,735	1,503,453	6,006,106	3,828,895
North Carolina	65,700	65,128	166,166	91,187	374,382	317,959	606,248	474,274
Ohio	3,453,360	1,748,075	1,086,219	443,060	908,441	423,059	5,448,000	2,614,194
Oklahoma	15,802	7,441	170,928	75,947	129,568	85,314	316,298	168,702
Oregon	218,379	157,267	163,407	77,979	107,071	89,606	488,857	324,852
Pennsylvania	1,640,049	1,110,039	1,196,793	769,994	1,313,268	846,916	4,150,110	2,726,949
Rhode Island	61,373	72,255	.....	.....	32,095	29,013	93,468	101,268
South Carolina	28,425	27,684	69,131	58,019	70,392	77,354	167,948	163,057
South Dakota	14,120	11,300	.....	.....	85,434	61,994	99,554	73,294
Tennessee	345,765	264,288	628,979	220,333	150,830	85,467	1,125,574	570,088
Texas	196,051	119,218	75,799	43,510	345,443	281,389	617,293	444,117
Utah	16,000	19,200	3,000	1,500	.....	.....	19,000	20,700
Vermont	17,978	13,563	.....	.....	11,460	11,391	29,438	24,954
Virginia	1,931,852	1,185,271	679,119	395,180	218,015	147,900	2,828,986	1,728,351
Washington	162,777	87,259	20,459	12,269	24,029	20,668	207,265	120,196
West Virginia	197,245	113,525	464,044	222,952	72,641	46,042	733,930	382,519
Wisconsin	1,000,667	635,618	104,325	42,653	604,884	396,407	1,709,876	1,074,678
Wyoming	.....	.....	.....	.....	9,117	10,840	9,117	10,840
	21,786,833	13,329,365	11,904,679	6,108,408	15,672,964	10,723,993	49,364,476	30,161,766

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Crushed stone sold in the United States in 1914 and 1915, by States and Territories—Continued.

1915.

State or Territory.	Road metal.		Railroad ballast.		Concrete.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	49,972	$42,116	2,200	$554	77,705	$45,443	129,877	$88,113
Arizona	.....	.....	14,462	7,173	1,250	2,000	15,712	9,173
Arkansas	113,606	75,044	83,685	55,493	105,736	72,209	303,027	202,746
California	1,567,505	902,462	661,679	302,261	1,589,231	917,507	3,818,415	2,122,230
Colorado	5,842	7,178	3,750	2,200	19,189	22,171	28,781	31,549
Connecticut	728,014	330,174	265,720	131,055	434,307	221,052	1,428,041	682,281
Delaware	21,742	21,707	11,088	11,770	24,929	25,296	57,759	58,773
Florida	102,517	56,381	125,000	50,000	96,407	108,003	323,924	214,384
Georgia	90,244	54,696	33,907	26,136	113,746	95,983	237,897	176,815
Hawaii	34,413	36,366	15,051	15,000	49,489	67,176	98,953	118,542
Illinois	1,625,250	747,718	814,443	341,126	2,196,083	1,072,268	4,635,776	2,161,112
Indiana	1,792,261	910,462	150,047	55,649	65,325	33,262	2,007,633	999,373
Iowa	32,437	28,397	187,978	78,886	417,866	261,799	638,281	369,082
Kansas	20,046	15,591	327,496	169,117	296,766	222,524	644,308	407,232
Kentucky	609,995	379,234	769,886	327,578	132,233	78,952	1,512,114	785,764
Louisiana	830	664	7,907	6,326	17,921	14,337	26,658	21,327
Maine	1,747	1,409	3,132	2,349	5,651	4,123	10,530	7,881
Maryland	324,153	274,644	375,172	240,899	236,727	189,370	946,052	704,913
Massachusetts	738,015	599,555	140,638	72,088	506,350	434,132	1,385,003	1,105,775
Michigan	510,524	224,734	60,455	19,684	417,723	239,351	988,702	483,769
Minnesota	59,733	57,286	.....	.....	348,059	271,753	407,792	329,039
Missouri	553,049	383,022	167,319	82,005	658,874	519,050	1,379,242	984,077
Montana	23,875	5,186	809	178	16,750	8,303	41,434	13,667
Nebraska	.....	.....	26,913	11,913	281,866	249,269	308,779	261,182
New Hampshire	14,845	12,416	.....	.....	14,767	11,001	29,612	23,417
New Jersey	1,059,749	822,214	385,000	260,426	363,513	297,626	1,808,262	1,380,266
New Mexico	547	407	8,000	4,800	159,375	225,950	167,922	231,157
New York	2,900,165	1,623,570	1,277,228	700,255	1,591,393	982,736	5,768,786	3,306,561
North Carolina	69,238	73,404	163,815	92,026	357,934	308,047	590,987	473,477
Ohio	3,088,599	1,567,676	1,453,243	603,599	979,973	464,268	5,521,815	2,635,543
Oklahoma	46,430	29,764	459,107	205,765	208,253	133,232	713,790	368,761
Oregon	290,648	202,580	182,197	80,433	222,039	151,399	694,884	434,412
Pennsylvania	1,844,626	1,218,446	1,139,340	732,073	1,149,076	751,391	4,133,042	2,701,910
Rhode Island	91,872	110,167	.....	.....	83,750	109,730	175,622	219,897
South Carolina	27,111	26,566	50,714	49,678	125,981	117,070	203,806	193,314
South Dakota	11,292	8,487	.....	.....	108,850	86,415	120,142	94,902
Tennessee	441,298	369,296	395,740	132,655	144,498	86,027	981,536	587,978
Texas	269,151	164,865	60,607	31,212	373,344	263,307	703,102	459,384
Utah	6,500	3,750	1,500	750	5,621	2,810	13,621	7,310
Vermont	14,929	13,269	156	125	7,514	7,374	22,599	20,768
Virginia	2,193,898	1,538,149	933,317	507,966	255,716	140,003	3,382,931	2,186,118
Washington	213,039	111,461	3,120	2,388	470	500	216,629	114,349
West Virginia	196,068	120,106	535,712	251,503	74,711	50,412	806,491	431,021
Wisconsin	914,295	555,927	70,508	33,800	584,252	366,257	1,569,055	955,984
Wyoming	.....	.....	.....	.....	9,383	8,160	9,383	8,160
	22,710,070	13,735,546	11,368,041	5,698,894	14,930,596	9,739,048	49,008,707	29,173,488

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Prior to the advent of crushed stone, building and monumental stone were considered the chief stone products. The stone crushed for concrete, however, took the place of a large quantity of building and foundation stone. In 1907, owing particularly to the great increase in the building of macadam roads, the total value of crushed stone exceeded that of exterior building stone, and the excess in value of crushed stone over exterior building stone has been increasing almost continuously ever since. Its greatest value, $31,677,871, was attained in 1913. The only years in which the marketed production of crushed stone has decreased are years of financial depression, 1908, 1914, and 1915. It is a striking fact that the decreases in these years were in the sales of crushed stone for concrete and railroad ballast, whereas crushed stone for road metal increased. In several of the years marked by increase in value of total crushed stone, however, the value of road metal remained almost stationary or declined.

Road metal has always been by far the most important crushed-stone product. Crushed stone for concrete, valued at less than $2,000,000 in 1901, has risen continuously in value, except in 1908, 1914, and 1915, and in 1913, the record year, was valued at nearly $11,000,000. Crushed stone for railroad ballast, valued at about $2,300,000 in 1901, has also increased in all but the three years noted, though not so markedly as crushed stone for concrete. Its maximum value in 1913 was nearly $7,900,000.

As crushed stone has been the most important product of the stone industry since 1907, special attention is here given to it.

The marketed production (which reached its maximum value in 1913) declined steadily during 1914 and 1915. The decrease in 1915, compared to 1914, was 355,769 short tons, or 0.7 per cent, in quantity and $988,278, or 3.3 per cent, in value. The decrease according to the accompanying table was in crushed stone for railroad ballast and concrete, whereas there was increase in quantity and value of crushed stone for road metal. The average prices per ton for these uses decreased 1 to 3 cents, and the decrease in average price for total crushed stone was 1 cent.

Of the different kinds of stone crushed, granite increased 22,768 tons in quantity but decreased $151,801 in value and 3 cents in average price per ton; basalt and related rocks (trap rock) increased 744,709 tons in quantity and $171,836 in value, but decreased 4 cents in average price per ton; limestone, which forms a larger part of the crushed-stone production than all other kinds of stone combined, decreased 1,091,633 short tons in quantity, $958,886 in value, and 1 cent in average price per ton; crushed sandstone, which increased in quantity and value in 1913 and 1914, decreased slightly in 1915—31,613 tons in quantity, $49,427 in value, and 1 cent in average price per ton.

The changes in value according to different uses reflect well the industrial conditions of the last two years. Activity in building roads, which increased considerably in 1913, continued to increase during the two following years, and, being paid for largely from State and municipal funds, was not appreciably affected by business depressions. Sales of crushed stone for concrete were severely affected by curtailment of building operations which persisted until late in 1915, and sales of crushed stone for railroad ballast diminished.

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Crushed stone does not represent all the material used for these purposes. In almost every State a large quantity of gravel, often crushed gravel, is used for road metal, railroad ballast, and concrete. In 1914, 39,212,858 short tons of gravel, valued at $9,398,897, and in 1915, 37,972,548 short tons, valued at $9,598,391, were sold for these purposes. Sand sold for railroad ballast amounted to 2,116,429 short tons, valued at $322,740, in 1914 and to 2,688,766 short tons, valued at $350,125, in 1915. In Missouri a considerable quantity of railroad ballast and road material is obtained from the tailings of the concentrating mills at zinc mines, which is put on the market as "chats" and consists of small angular fragments of chert and limestone. The zinc companies are glad to get rid of this waste material, which is loaded on the cars by the railroads of the district at a cost of 6 or 8 cents a ton. It makes more than ordinarily good roads and is widely distributed throughout the Mississippi Valley States. It sells at prices ranging from 50 cents to $1 a ton. In the neighborhood of the mines the material sells for about 15 cents a ton. The average price per ton for the total sales is about 15 cents. The sales of chats in 1914 and 1915 were as follows:

"Chats" sold in Missouri in 1914 and 1915.

	Railroad ballast (short tons).	Other uses (short tons).	Total (short tons).	Value.
1914	1,687,331	583,440	2,270,771	$340,616
1915	1,713,884	595,307	2,309,191	346,379

In Tennessee and Alabama a quantity of chert is used for road metal. Crushed slag from the blast furnaces of various States, at an average value of about 25 cents a ton, furnishes a valuable road metal; it is also used as railroad ballast and for concrete and roofing material.

According to the table on page 829, 8 States produced and sold in 1915 crushed stone valued at more than $1,000,000 each, as follows, by rank, New York, Pennsylvania, Ohio, Virginia, Illinois, California, New Jersey, and Massachusetts. In 1914 there were 11 States, including the States already named, and also Indiana, Missouri, and Wisconsin. Indiana fell less than $700 below the $1,000,000 mark, and Missouri and Wisconsin had values exceeding $950,000. Virginia, sixth in 1914, advanced to fourth place in 1915, with a gain of 553,945 short tons in quantity and of $457,767 in value. Over three-fourths of this gain was chiefly in road metal and the remainder in railroad ballast; there was a slight decrease in crushed stone for concrete. California dropped from fourth to sixth place, owing to a decrease in value of $114,529, although its quantity increased 109,950 short tons. Road metal decreased in both quantity and value, but railroad ballast and crushed stone for concrete showed increase in quantity and decrease in value. The other leading States held the same rank in 1914 as in 1915.

Analysis of the table shows that increase or decrease according to use varied from State to State. Crushed stone for road metal

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increased in 20 and decreased in 22 States. Five of the 8 leading States showed increase, and the prominent gain by Virginia (more than $350,000) alone amounted to seven-eighths of the total increase in value of road metal. New York showed a gain of over $200,000, and New Jersey, Connecticut, Pennsylvania, and Tennessee gains of over $100,000 each. Ohio, Indiana, and Illinois showed decreases of more than $100,000 in crushed stone for road metal.

Crushed stone for railroad ballast increased in value in 16 and decreased in 25 States. Seven of the 16 States showing increase were on the Atlantic coast. The others were scattered. Ohio, Oklahoma, and Virginia showed increase of more than $100,000 each; Kentucky and New York showed decrease of more than $200,000 and Kansas of more than $100,000. New York's decrease in railroad ballast offset its increase in road metal.

Crushed stone for concrete increased in 19 and decreased in 25 States. All the Middle Atlantic States showed decrease, but elsewhere there was no marked predominance of States with increase or decrease. Only Illinois showed an increase of more than $100,000; on the other hand, New York's decrease exceeded $520,000, Alabama's exceeded $300,000, Missouri's exceeded $100,000, and Pennsylvania's and Maryland's decreases were nearly $100,000 each.

Of 46 States, including Hawaii, from which a marketed production of crushed stone was reported, 18 showed increase and 28 decrease in total value. Six States showed increase of more than $100,000, and 9 showed decrease of more than $100,000. Oklahoma, with a total gain of $200,059, was second to Virginia, and was followed in order by Connecticut, New Jersey, Rhode Island, and Oregon. The greatest decrease in value was in New York—$522,334—the next greatest was in Alabama—$360,752—Kentucky was third, with a decrease of $209,671, and was followed in order by Indiana, Missouri, Maryland, Wisconsin, California, and Kansas. West Virginia, Nebraska, and Oregon showed increase, and Maine, Indiana, Wisconsin, and Louisiana showed decrease in value for each of the three uses shown in the table.

In addition to the general conditions already cited, some producers reported local conditions which tended to reduce sales of crushed stone in 1915. Some producers in New York reported that heavy rains, especially in the spring, greatly delayed road making and building construction and so crowded work into the closing months that a considerable part of the orders remained unfilled at the close of the year. Keen competition both in 1914 and 1915 caused a lowering of prices in the vicinity of Syracuse, but wages there advanced 15 to 20 per cent. Labor, sufficient in some places, was scarce in others, especially in contract work, and minor labor disturbances further retarded work where crushed stone was used.

In New Jersey and parts of Pennsylvania labor was reported 10 per cent higher and cost of supplies, especially explosives, greatly increased. Prices in Pennsylvania were lower, owing especially to competition with gravel and crushed slag.

In central Ohio delays caused by unfavorable weather conditions curtailed the marketing of crushed stone until late in the year and

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many contracts were carried over into 1916. Labor was scarce and expensive in the latter part of the year and in the early part of 1916. Prices were reduced, owing to sharp competition with gravel.

Indiana's increase was attributed largely to labor troubles in Chicago. Producers in Illinois, however, did not refer especially to the labor troubles, but one producer reported a growing tendency on the part of contractors to delay in starting the season's work, thereby crowding the marketing of crushed stone largely into the months of July, August, September, and October. Unfavorable weather conditions in Indiana and Illinois, which delayed work planned for spring until late summer, caused a reported decrease of about 25 per cent in the output of Kentucky producers who supply markets in those two States.

In some parts of Wisconsin activity in road building developed a good demand for crushed stone, especially limestone, which is growing in favor for use in country roads. In the Milwaukee and Chicago regions, however it is reported that crushed stone is being supplanted by crushed and washed gravel, which is cheaper and gives satisfactory results for concrete highways.

In Minnesota and Iowa, as in some of the more eastern States, prices were lowered by competition with gravel, and in parts of Iowa curtailment of public improvements, especially road making, and of railroad work, caused further competition and lowering of prices. The total quantity and value of crushed stone in Iowa, however, increased in 1915. Unfavorable weather conditions also lessened demand in the summer, but demand in the fall was reported good by some producers.

In Nebraska the good demand for crushed stone was shown by increase in quantity and value for all uses, but trouble was caused by rains and by the labor problem. During the last few years there has been a marked increase in the demand for small sizes of crushed stone for all kinds of work. One-inch stone is now used in concrete work where 2-inch and 3-inch stone was formerly used, and all stone for concrete must be screened to meet requirements.

In parts of Kansas decreased demand, owing to competition with gravel for concrete aggregate, was reported.

Missouri's decrease may be partly due to the increased use of "chats" or mine tailings in parts of the State; also to the fact that a considerable demand was supplied by stone excavated from the Mill Creek sewer in St. Louis and sold by the contractors for a low price. Reports from Kansas City state that its steady growth will necessitate building of roads, sewers, and street car lines, all of which will involve the use of considerable crushed stone and concrete.

Oklahoma's great increase was attributed mainly to improved conditions resulting from increase in quantity and price of farm products. The increased sales of crushed stone were principally for railroad ballast and to a less extent for road metal. The State sold crushed stone produced by convict labor in competition with privately owned quarries.

In Texas the crushed-limestone industry was unfavorably affected by competition with gravel for roads.

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DISTRIBUTION.

The relative extent to which different kinds of stone are crushed depends in large part on their geographic distribution and to a considerable extent on their adaptability to different uses. The kinds produced in each State are shown in the tables for granite, basalt, limestone, and sandstone.

The rock formations in New England are for the most part igneous and metamorphic rocks, classed in this report as granite. They are crushed in considerable quantity in eastern Massachusetts and Rhode Island, where they are conveniently situated with respect to market. Sales in each of these States were valued at about $200,000 in 1915. Several of the quarries near Boston are altered volcanic rocks, mostly rhyolites, and are known collectively as felsite. Basalt and diabase are widely distributed in New England, but the most important deposits are restricted to the area of Triassic rocks in central Connecticut and Massachusetts. Here they outcrop in long ridges very conveniently situated for quarrying and with respect to rail transportation and some are close to tide water. Sales of crushed basalt and diabase in 1915 were valued at about $676,000 in Connecticut and at $617,000 in Massachusetts. The most extensive sandstone deposits of New England are also in the Triassic area of Connecticut and Massachusetts, but they are so inferior to the basalt and diabase that there is no demand for them. The crushed sandstone credited to Massachusetts, and valued at nearly $300,000 in 1915, consists chiefly of the hard Roxbury conglomerate, which is extensively used in Boston and vicinity. It also includes a small quantity of slate that lacks the characteristic cleavage of roofing material. Although limestone and marble are abundant along the western edge of New England and in the vicinity of Rockland, Me., they are not so favorably situated near large markets for crushed stone as the rocks previously mentioned. Limestone comprised more than half the crushed stone sold in Vermont in 1915, but the total was valued at only about $20,000.

The Middle Atlantic States, so far as crushed stone is concerned, may be divided into a southeastern part consisting largely of igneous and metamorphic rocks and a northwestern part composed mostly of sandstones and limestones. The southeastern part extends from the lower Hudson River valley across northeastern New Jersey, southeastern Pennsylvania, and east-central Maryland into Virginia. Granites and rocks of similar mineral composition are abundant throughout and furnish a considerable quantity of crushed stone but are of relatively minor importance except in Maryland, where crushed stone sold in 1915 was valued at about $529,000. Basalt and diabase are the most important; they form long ridges in areas of Triassic rocks. The diabase of the Palisades extends along tidewater in Hudson River and is especially valuable, as it can supply an extensive market and is purchased where stone of excellent wearing quality is demanded, even in districts with a large local production of crushed stone. It is probable, however, that a considerable part of the Palisades will be taken over by the park commissioners and a number of quarries at tidewater abandoned. The

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other ridges lie close by important railroads. Crushed stone sold from these deposits in 1915 was valued at nearly $1,260,000 in New Jersey, nearly $1,080,000 in Pennsylvania, and about $760,000 in New York.

Production of crushed sandstone and limestone in the southeastern area is insignificant, except in Pennsylvania. In southeastern Pennsylvania and western New Jersey, a metaphoric slate or argillite, here classed with sandstone, is produced in considerable quantity. This stone has been so changed by the influence of diabase intrusions that its hardness, toughness, and coefficient of wear are essentially the same as those of diabase and basalt, or true "trap rock."

In the northwestern area limestone, though far from being the most abundantly exposed, forms about seven-eighths of the stone crushed. It is situated near important railroads, which reach cities of both moderate and large size west of the Appalachian Mountains. The limestone, though far inferior to basalt and diabase in general wearing qualities, is very satisfactory for light traffic, railroad ballast, and concrete, and is favored by transportation. Sales of crushed limestone in 1915 were valued at more than $2,290,000 in New York and $1,225,000 in Pennsylvania. About half the value in each State was for road metal. In contrast to these figures the total value of sandstone in 1915 was about $165,000 in New York and about $314,000 in Pennsylvania. Sandstone in New York included bluestone, the best quality of which is very resistant to abrasion, and a fine, hard conglomerate, or "grit," from Rensselaer County, whose wearing qualities very nearly equal those of basalt or "true trap rock." Sandstone in Pennsylvania included bluestone and the argillite, already noted, in the southeastern part of the State.

The South Atlantic States, except Florida, are traversed by a broad area, composed mostly of igneous and metamorphic rocks, corresponding to the southeastern area of the Middle Atlantic States. The area of limestones and sandstones, cited in the last paragraph, is represented along the western part of Virginia, but passes west of the States farther south. Granite is produced in considerable quantity in central Virginia, North Carolina, South Carolina, and Georgia. Basaltic rocks, though present, are not favorably situated, and no production of them has been reported. Crushed sandstone was used in considerable quantity in Virginia in 1914 and 1915, and to a small extent in North Carolina. Limestone in the western part of Virginia furnished well over half the total crushed stone sold in that State in 1915; it was valued at about $1,320,000; and nearly two-thirds of it was used for road metal. Limestone is the only rock in Florida suitable for crushing; its sales in 1914 were valued at about $214,000.

In the region between the Atlantic Coast States and Mississippi River, Michigan, Wisconsin, and Minnesota are the only States containing large bodies of granitic and basaltic rocks. Crushed basaltic rocks sold in Minnesota were valued at more than $76,000 in 1915, and crushed granite in Wisconsin was valued at $228,000. Limestone, though constituting less than half the surface rock of this region, is favorably situated with respect to large industrial

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centers and as a whole is better adapted than sandstone for use as crushed stone. To these facts are due the large sales of crushed limestone in Ohio and Illinois, valued in both at more than $2,000,000; in Indiana, valued at nearly $1,000,000; and in the other States of the region, at values ranging from $180,000 to $785,000. The same general conditions exist in Iowa, Missouri, and northern Arkansas. Missouri contains a small area of granitic rocks, too remote from important cities to be of importance as crushed stone. Arkansas's igneous rocks, including syenite and dark varieties here classed as basaltic, are in the vicinity of Little Rock, and the basaltic rocks yield the greater part of the crushed stone production of the State.

All the Southwestern States contain small areas of igneous rocks, but none of them are very important as sources of crushed stone. Limestone represents only a small fraction of the total area of these States but is the chief source of crushed stone in Oklahoma and Texas, the value in 1915 for each State exceeding $365,000. The same relations between limestone and sandstone apply here as in the eastern Central States, but New Mexico is an exception in showing sales of crushed sandstone valued at more than $223,000. This stone was used in concrete for the Elephant Butte dam.

In Kansas and Nebraska limestone is the only source of crushed stone, though its exposures are limited to small parts of each State. The greater part of these two States, as well as of the Dakotas and eastern Montana, are covered by sandstones and shales of Cretaceous and Tertiary age, which as a rule are not sufficiently consolidated to yield a good quality of crushed stone. In the western interior States, including Colorado, Wyoming, Idaho, Utah, Nevada, and the western part of Montana, there is an abundance of igneous rocks, limestone, and sandstone suitable for crushing, but demand for crushed stone in these States has been very small.

The Pacific Coast States contain the same variety of suitable rocks, including the most extensive area of basalt on the continent. This area is close to the principal markets of Oregon and Washington and furnishes almost the entire supply of crushed stone in these States. Crushed basaltic rocks sold in California were reported as valued at nearly $950,000, a little less than half the total for the State. Crushed granite in California was reported as valued at more than $810,000, crushed sandstone at nearly $245,000, and crushed limestone at $123,000. The large area of California and the availability of different kinds of stone for different cities account to a great extent for the large production of each kind. The sandstone that is crushed is largely a hard, dense variety that closely resembles a fine-grained dark igneous rock, and also includes a certain quantity of crushed chert.

As a summary to the foregoing paragraphs, it is interesting to note that in regions where they are reasonably near to markets, basaltic rocks are used in preference to other kinds of stone; that the granitic rocks and limestones are used where they are the most available; and that sandstones are the least desirable for crushing. In States with a large production of crushed sandstone, the stone is of exceptionally desirable character.

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RELATIVE QUALITIES OF CRUSHED STONE.

ROAD METAL.

The qualities of different kinds of crushed stone have been under investigation for years by the Office of Public Roads and Rural Engineering, United States Department of Agriculture, which has recently issued two reports[1] on the subject, one by Jackson and one by Lord. These reports may be obtained from the Department of Agriculture, or from the Superintendent of Documents, Washington, D. C. Where rock is intended for water-bound macadam construction, the most essential qualities to be determined are (1) hardness (resistance to abrasion), (2) toughness (resistance to impact of traffic), and (3) binding power or cementing value (ability of the rock powder when in contact with water to bind or cement the larger rock fragments and prevent their displacement under the shearing action of traffic). The specific gravity and weight per cubic foot of the stone are important in the calculation of the quantity of stone required for a certain area of road. The methods for determining these properties are fully described in Jackson's report. The results of the tests are stated in the following terms:

The per cent of wear or the per cent by weight of rock particles below one-sixteenth of an inch in size worn off during the abrasion test.

The French coefficient of wear, obtained by dividing 40 by the per cent of wear. A coefficient of wear below 8 is called low; from 8 to 13 medium; from 14 to 20 high; above 20 very high. Rocks of very high resistance to wear are suited only for roads subjected to heavy traffic, as explained on page 838.

Hardness, the loss of weight of a faced core of rock by abrasion by sand fed upon a steel disk during 1,000 revolutions. In order to report the results on a convenient scale one-third of the loss of weight in grams is subtracted from 20; with results below 14, rocks are called soft; from 14 to 17, medium; above 17, hard.

Toughness is expressed by the height in centimeters of a standard weight required to rupture the test piece. Results below 13 indicate a low, from 13 to 19 a medium, and above 19 a high degree of toughness.

The cementing value is determined by the number of standard blows of a small hammer required to destroy a briquet of rock powder that has been mixed with water into a stiff paste and dried. Cementing values below 10 are called low; from 10 to 25, fair; from 26 to 75, good; from 76 to 100, very good; and above 100, excellent.

Results of tests show that samples of a single kind of rock may vary within wide limits,[2] but as a rule there is a marked relation between the mineral composition and texture of the rock and the results of the tests. These have been discussed by Lord,[3] whose statements, together with remarks from a few other sources, are summarized in the following paragraphs.

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[1] Jeckson, F. H., jr., Methods for the determination of the physical properties of road-building rock: U. S. Dept. Agr. Bull. 347, 27 pp., 1916.
Lord, E. C. E., Relation of mineral composition and rock structure to the physical properties of road materials: U. S. Dept. Agr. Bull. 348, 26 pp., 1916.

[2] The maximum and minimum results of tests made prior to Jan. 1, 1914, are given in a circular (Form 28) published by the Office of Public Roads and Rural Engineering, U. S. Dept. Agriculture.

[3] Op. cit., pp. 11-26.

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Igneous rocks as a class, owing to their more uniform structure and preponderance of hard silicate mineral constituents, have better wearing properties than either sedimentary rocks or crystalline schists. The coarser granular igneous rocks are in general less tough and have wearing properties inferior to fine-grained or flinty igneous rocks. Granular rocks containing much mica or secondary chlorite or serpentine have exceptionally low wearing properties, whereas those containing large percentages of hornblende and augite are superior in toughness and resistance to abrasion. Granular rocks containing much quartz have inferior cementing values.

According to Goldbeck and Jackson [1] granites as a class are unfit for use in any but foundation courses of water-bound macadam roads, owing to lack of toughness and binding power. Hotchkiss [2] also calls attention to lack of binding power of most granites of Wisconsin, but states that the coarser-grained varieties with conspicuous feldspar crystals become pulverized with sufficient rapidity to furnish the proper amount of binding material and that the coarse, jagged surfaces of the fragments serve to lock them firmly together. For the average country road, however, most of the granites of Wisconsin need to be bound with limestone screenings, fine clayey gravel, or bituminous material.

Of the fine-grained and dense igneous rocks those high in silica (rhyolites and other felsites) are on the whole harder though less tough than those low in silica (basalt and diabase), which give the best results on roads subjected to heavy traffic. They are too hard and tough for roads of light traffic, such as parkways. Glassy rocks are generally inferior to the crystallized varieties. Alteration increases the cementing value, especially of basaltic rocks, but detracts from their other properties. The cementing quality is attributed largely to certain amorphous compounds closely related to kaolin and chlorite in composition.

The generally inferior qualities of sedimentary as compared with igneous rocks is due in limestones to the softness of their essential minerals, calcite and dolomite, and in sandstones to the incomplete cementation of the constituent grains. Although one might assume that the relatively high degree of solubility of pulverized calcite, as compared with that of silicate minerals, should give limestones an "excellent" cementing value, results of laboratory tests prove them to have only a "good" average cementing value—54 for limestone and 33 for dolomite, compared with averages of 118 for rhyolite, 188 for andesite, and 144 for altered basalt. The average cementing values for unaltered basalt and diabase and for the coarser grained igneous rocks are nearly all below the cementing values of limestone and dolomite. Limestones and dolomites containing an appreciable amount of quartz with some kaolin or clay are tougher and have lower percentages of wear and higher cementing values than the purer varities. Marble, or well-crystallized limestone, is inferior to average limestone in all properties.

Test data on sandstones show them to average as high as limestones and dolomites in cementing value, or even higher, and to surpass

[1] Goldbeck, A. T., and Jackson, F. H., jr., The physical testing of rock for road building: U. S. Dept. Agr. Office Pub. Roads Bull. 44, p. 29, 1912. A revision of this report by Prévost Hubbard and F. H. Jackson, jr., was published July 20, 1916, as Bull. 370 (The results of physical tests of road-building rock).

[2] Hotchkiss, W. O., and Steidtmann, Edward, Limestone road materials of Wisconsin: Wisconsin Geol. and Nat. Hist. Survey Bull. 34, pp. 17–18, 1914.

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them in toughness. They are approximately equal to limestone and dolomite in hardness but have a higher average percentage of wear.[1] Calcareous sandstones give average results superior in all respects to limestones, dolomites, and other sandstones, except that feldspathic sandstones have a higher cementing value. Goldbeck and Jackson,[2] however, state that laboratory tests of sandstones do not agree so closely as they should with results in practice, especially as regards wearing and binding qualities; for, although these tests frequently run high in the laboratory, it is undoubtedly true that, with some exceptions, sandstones are suitable only for foundation courses. The principal test for ordinary sandstone therefore is to determine whether it has sufficient strength to withstand the weight of the roller. The difference between tests of sandstones and the results of their actual use may be due in large part to their relatively high degree of porosity and to the nature of the matrix that binds the sand grains. Absorption of water tends to soften the stone and lessen its wearing qualities; the matrix may become so softened or leached by weathering as to promote rapid disintegration, especially in regions characterized by frosty weather.

Special discussion may be inserted here of rocks (chert, quartzite, conglomerate, and slate or argillite) classed with sandstone in the foregoing tables. Tests of chert by the Office of Public Roads and Rural Engineering prove its average per cent of wear (9.4) to be distinctly inferior to that of both limestones and sandstones, its average hardness (18.2) to be superior to that of both limestones and sandstones, its toughness (12) superior to that of limestones and quartzose sandstones but somewhat inferior to that of feldspathic sandstone, and its cementing value (30) inferior to that of both limestones and sandstones. It has been found, however, to develop good binding qualities on the road. Quartzite, composed essentially of the hard mineral quartz with its grains thoroughly cemented is superior to all other sedimentary rocks and equal to or superior to most igneous rocks in percentage of wear, hardness, and toughness, but is inferior to all in cementing value. Only 12 samples of conglomerate had been tested by the Office of Public Roads and Rural Engineering up to January 1, 1914. These gave results extending over a wide range as other kinds of stone did also, of which many more samples were tested. Their average values are accordingly less significant and have not been published. The Roxbury conglomerate, of Massachusetts, the only one extensively crushed, consists chiefly of pebbles of quartzite and flinty rhyolite in a matrix of hard feldspathic sandstone. Its physical properties, therefore, may be regarded as at least equal to the average of these kinds of stone. The name "slate" may represent soft rocks with a highly developed cleavage and very inferior as road metal, or rocks similar in origin, but harder, void of cleavage, and of fair to superior quality. The latter are more aptly termed argillite. They have been so changed in mineral composition and texture by geologic processes that they are much better for use as crushed stone than the name slate would ordinarily imply. Tests of 71 samples of slates, including argillites, by the Office of Public Roads and Rural

[1] Lord, E. W. C., op. cit., table facing p. 2. On p. 18 is a tabulated comparison showing relations of mineral composition to physical properties; the sandstones considered have lower percentages of wear than the limestones and dolomites.

[2] Op. cit., p. 30.

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Engineering yielded the following results: Percentage of wear (4.4) and hardness (15), both poorer than those of igneous rocks but better than those of limestones and ordinary sandstones; toughness (17) and cementing value (57) both superior to the averages of granite, limestone, and sandstone but inferior to those of basaltic and other volcanic rocks. A sample of argillite from eastern Massachusetts, tested by H. W. Hayward, showed a toughness of 21, superior to the averages for nearly all stones published by the Office of Public Roads and Rural Engineering; and a percentage of wear of 3 (French coefficient of wear 13¾) equal to, or better than, the averages of all igneous rocks except basalt and diabase, and decidedly superior to the averages of limestones and sandstones.[1] Three of the argillite samples from Green Lane, Montgomery County, Pa., tested at the Office of Public Roads and Rural Engineering[2] show the following range in quality:

Tests of argillite from Montgomery County, Pa.

No.	Percentage of wear.	French coefficient of wear.	Hardness.	Toughness.	Cementing value.
1037	2.6	15.2	17.9	17	179
2049	1.7	23.5	18.9	40	23
2172	2.6	15.5	15.4	10	59

According to Lord[3] screenings of the coarser-grained igneous rocks are more rectangular than those of fine-grained or dense rocks, which are splintery and wedge shaped, whereas those of the more loosely textured sandstones are of more rounded shape. Dense, massive limestones tend to give wedge-shaped fragments. Wedge-shaped screenings tend to produce a firmer and more permanent mechanical bond with the coarser fragments than screenings of rectangular or rounded form.

The foregoing remarks apply to stone to be used as water-bound macadam. Where bituminous material or Portland cement forms the binder, the cementing value of the stone is of less importance, but hardness, toughness, and percentage of wear is still of prime importance for surface stone. For the road foundation crushing strength is the property of most critical value. It may be inferred that, as a rule, a stone of satisfactory wearing qualities for surface use has a requisite crushing strength. Some sandstones, limestones, and altered igneous rocks whose hardness and toughness are inferior, have crushing strengths sufficient for their use in road foundations.

RAILROAD BALLAST.

No reports on the comparative adaptability of different kinds of stone for railroad ballast have come to the writer's attention. The principal requirements appear to be resistance to weathering, sufficient strength to support the weight of traffic, and wearing qualities sufficient to withstand the grinding of surfaces and jarring

[1] Data furnished by J. H. White Co. (Inc.), Boston and Watertown, Mass.
[2] Goldbeck, A. T., and Jackson, F. H., jr., The physical testing of rock for road building: U. S. Dept. Agr. Office Pub. Roads Bull. 44, p. 70, 1912.
[3] Op. cit., p. 13.

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caused by passing trains. Shaly rocks and very clayey sandstones may be considered inferior for railroad ballast, as their rapid disintegration into fine flakes and grains that are readily washed away from the roadbed tends to remove support from the railroad ties. Stones of inferior hardness and toughness for road metal, but without such a marked tendency to disintegrate may be very satisfactory as ballast for railroads of comparatively light traffic; for lines of heavy traffic, hardness and toughness are of increasing importance. So far as present uses are concerned, there is practically no choice among the different kinds of stone other than those noted.

CONCRETE.

There has been more or less speculation as to the relative merits of different kinds of stone and gravel as concrete aggregate, but no kind has been proved distinctly superior to another. The principal natural properties of stone for this purpose are homogeneity of structure, and crushing and transverse strengths. Nearly all natural stones, except poorly consolidated sedimentary rocks, have crushing and transverse breaking strengths equal or superior to those of Portland cement mortar and concrete a year old. The strength and other properties of concrete as affected by materials and methods of preparation have been investigated by Wig, Williams, and Gates, of the Bureau of Standards,[1] from whose report the following statements are abstracted.

The principal requisites for a concrete aggregate are cleanliness, strength, homogeneity of structure, and proper gradation of particles. The coarse aggregates commonly used in concrete are granite, trap, gravels, limestones, sandstones, slags, and coal cinders. These materials differ greatly in strength, hardness, porosity, and available gradation of size of particles. In any single type of material there can probably be found as great a range in quality as is commonly found between any two of the types, except cinders. It is generally considered that a granite is superior to a limestone as a concrete aggregate, but the range of quality among granites is so great that some limestones in use are superior to many granites. Comparative tests are necessary to determine the better, where two or more kinds of material are available. Specifications for concrete materials sometimes favor a limestone in preference to a gravel, because of the fact that gravel is usually round and smooth and that crushed limestone is more angular and sharp—qualities that are supposed to aid in the production of a stronger concrete. Although this fact has not been demonstrated, there may be an interlocking of the particles of the angular material which would contribute to a greater strength of a green concrete. The effect of this, however, must be lost after the concrete is a few weeks old and the adhesion between the stone and cement is sufficient to prevent a breaking of the bond with stresses up to the shearing strength of the stone. The roundness of the gravel aggregate has certain advantages in flowing into place more readily and thus producing a denser mixture with less spading or tamping than is required for an angular aggregate.

It is concluded from the results of about 20,000 tests that no particular kind of aggregate can be pronounced generally superior

[1] U. S. Bur. Standards Tech. Paper 58, 172 pp., 1916.

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to all other kinds. There are good and poor aggregates of each kind, and the strengths of concretes made up of several different materials of the same kind may vary as much as several hundred per cent, all other controllable factors being uniform. Furthermore, no standard of compressive strength can be assumed or guaranteed for concrete of any particular proportions made with any particular aggregate unless all the factors entering into its manufacture are controlled. Hardness and shearing strength of the concrete and gradation of particles in size are of more importance than the kind of aggregate used.

In most communities experience has demonstrated the satisfactory character of certain available aggregates and therefore no further tests are required except those which will detect variations in the quality; but untried materials should always be tested before using in important structures. Sand as a type of fine aggregate can not be said to be superior to limestone screenings.

Study of different groups of tests shows that there is a definite relation between the compressive strength and the proportion of cement to total aggregate. The strength varies in the same manner, although not in the same proportion, as the cement content in the mixture. This relation holds true only for any one combination of coarse and fine aggregate, and any change in gradation of total aggregate may affect the strength so as to neutralize the effect of change in the cement content.

With very few exceptions concretes show a direct increase in strength with age. The rates of increase depend upon a number of factors, such as rate of hardening of the cement, consistency of the mix, method of mixing and molding, curing, and proportioning of aggregate. No general equation, therefore, can be written to express the rate of increase in strength, as it will vary for every batch of concrete in which the factors vary.

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GEMS AND PRECIOUS STONES.

By WALDEMAR T. SCHALLER.

INTRODUCTON.

A review of the production of precious stones in the United States for the last five years shows that for very few of them is the value year by year at all constant and that for many of them the fluctuation is very great.

The value of beryl, exclusive of emerald, has remained fairly constant within the limits $1,600 to $2,600. Emerald included, the production of beryl has varied greatly and in general has decreased.

Californite is showing a slow but gradual increase, but the heavy production in 1907, 1909, and 1910 makes the output of the last five years seem almost insignificant.

Chrysoprase is also again slowly increasing in production, but the total of $234,545 from 1906 to 1911 makes the total of $1,345 from 1912 to 1915 look very small.

Diamonds have remained fairly constant, according to the published figures, although statistics for the production from Arkansas are not available. The values reported are those of isolated and scattered finds and seldom exceed a few thousand dollars annually.

Feldspar gems, garnet, peridot, rhodonite, and topaz have a relatively small and irregular production, which varies within rather narrow limits.

The production of quartz gems nearly doubled in 1915, amounting to $35,725, compared with $18,838 in 1914, $16,861 in 1913, and $21,779 in 1912. The largest items among the quartz gems are chalcedony and agate. The production of agate, chalcedony, and jasper increased appreciably in 1915, whereas that of amethyst, gold quartz, quartz crystal, smoky quartz, and rose quartz decreased.

Opals reached their maximum production in 1913, but since that year the output has greatly declined.

The production of sapphire from Montana, which fell from $238,635 in 1913 to $60,932 in 1914, increased to $88,214 in 1915.

Tourmaline shows a slight increase in value for 1915 over the two previous years, but the production in 1915 of $10,969 is small compared with $50,000 to $133,192 in the years from 1905 to 1909.

Turquoise has had about the same production for the last four years, but the total output for the four years from 1912 to 1915 is less than the production for any single year from 1908 to 1911 and for any single year from 1897 to 1905. The production of variscite was the smallest since 1907.

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The comparison for different years indicates that agate and chalcedony are the only gems that show a marked increase. Californite, beryl, chrysoprase, rose quartz, tourmaline, turquoise, and variscite show decrease in production, the remaining gems, sapphire, feldspars, garnets, spodumene, opal, peridot, topaz, rhodonite, and others of less importance show an irregular and varying output from year to year.

PRODUCTION.

The total production of gems and precious stones in the United States in 1915, as reported to the Geological Survey, was valued at $170,431. The production for 1914 was $124,651, the lowest since 1898, and that for 1915 is the second lowest.

Value of precious stones produced in the United States, 1911–1915.

	1911	1912	1913	1914	1915
Agates, chalcedony, onyx, etc.	$8,128	$9,978	$8,895	$8,312	$23,262
Amethyst	725	363	389	255	122
Benitoite	.....	150	.....	.....	.....
Beryl, aquamarine, blue, pink, yellow, etc.	2,505	1,765	1,615	2,395	1,675
Californite	150	275	152	1,425	[a] 1,535
Chiastolite	25	.....	.....	.....	.....
Chlorastrolite	1,992	350	.....	.....	[b]
Chrysoprase	13,550	220	.....	75	1,050
Copper ore gems, chrysocolla, malachite, etc.	800	1,085	2,350	1,280	1,120
Cyanite	.....	10	.....	.....	[b]
Diamond	2,750	1,475	6,315	765	608
Emerald	9,500	2,375	.....	.....	.....
Epidote	.....	10	.....	.....	.....
Feldspar, amazon stone, sunstone, etc.	175	1,310	1,285	449	368
Garnet, almandine, pyrope, hyacinth, etc.	2,065	860	4,285	1,760	4,523
Gold quartz	1,700	1,900	300	1,050	[c]
Hematite	.....	.....	.....	.....	126
Jade	.....	.....	.....	300	.....
Jasper, petrified wood, bloodstone, etc.	2,240	6,005	5,275	4,700	8,503
Opal	1,875	10,925	15,130	1,114	[d] 1,850
Peridot	360	8,100	375	100	[b]
Phenacite	.....	.....	.....	.....	[b]
Prase	.....	.....	25	.....	.....
Pyrite	.....	265	50	.....	1,042
Quartz, rock crystal, smoky quartz, rutilated quartz, etc.	2,140	2,448	1,640	4,046	[e] 2,437
Rhodonite	1,300	550	165	1,050	85
Rose quartz	1,744	865	337	400	350
Ruby	210	2,260	200	100	.....
Rutile	.....	.....	.....	.....	[b]
Sapphire	215,313	195,505	238,635	60,932	88,214
Smithsonite	25	650	50	50	[b]
Spodumene, kunzite, hiddenite	75	18,000	6,520	4,000	[b]
Thomsonite	1,500	450	.....	21	[b]
Topaz	2,675	375	736	1,380	862
Tourmaline	16,445	28,200	7,630	7,980	10,969
Turquoise and matrix	44,751	10,140	8,075	13,370	11,691
Variscite, amatrice chlorutahlite, utahlite	5,750	8,450	6,105	5,055	3,867
Miscellaneous gems	3,224	4,408	2,920	2,287	6,172
	343,692	319,722	319,454	124,651	170,431

[a] Including $10 vesuvianite not californite.
[b] Small production included under miscellaneous gems.
[c] Small production of gold quartz included under quartz.
[d] Including $225 wood opal.
[e] Including gold quartz.

The table of production aims to give the first value of the rough material. The value of the cut and polished gems is several times greater. The completeness and accuracy of the figures of production depend on the assistance of the gem miners and dealers, and their help is greatly appreciated. It is hoped that those few who have hesitated to furnish statements of production will cooperate in the future, on realizing that the individual statistical information

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furnished by them is considered confidential and that only the combined figures of production are published. The Geological Survey conducts a large correspondence on the subject of precious stones, and accurate information furnished by the individual producers enables the Survey to put intending purchasers of rough material directly in touch with them.

Under miscellaneous gems in the table of production are included apatite, calamine, chlorastrolite, crocidolite, cyanite, datolite, fossil coral, Iceland spar, lazurite, obsidian, peridot, phenacite, rutile, smithsonite, spodumene (kunzite), staurolite, thomsonite, titanite, and zircon.

RANK OF STATES.

Montana leads all the other States in the value of precious stones produced in 1915, a position it has held for the last five years. The output consists chiefly of sapphires, which constituted almost one-half of the total value of all precious stones produced in the United States in 1915. Moss agate was also a considerable item, the value ranking next to that of sapphires. Montana also produced some garnet and Iceland spar in 1915.

California ranks second in value of precious stones produced, the larger items being tourmaline, jasper, chalcedony, and agate, vesuvianite (californite), and spodumene (kunzite). Small quantities of beryl, garnet, rock crystal, smoky quartz, rose quartz, chrysoprase, topaz, diamond, and lazurite were also produced. A large production of kinradite, the spherulitic jasper from the vicinity of San Francisco, is noted.

Nevada produced chiefly turquoise and opal, with smaller outputs of copper ore gems and variscite.

Colorado produced various precious stones, jasper and chalcedony having the greatest value. Pyrite, smoky quartz, and feldspar gems were also produced, as were garnet, rock crystal, amethyst, rose quartz, turquoise, topaz, hematite, phenacite, and rhodonite.

Arizona produced chiefly turquoise and also garnet and the copper ore gems. Small outputs of smoky quartz, chrysoprase, onyx, agatized wood, crocidolite, peridot, obsidian, and jasper were reported.

Utah produced chiefly variscite; New Mexico, turquoise; Alaska, garnet; Virginia, staurolite; Maine, the pegmatite minerals, tourmaline, topaz, beryl, and smoky quartz; and Arkansas, diamond, rutile, garnet, rock crystal, and smoky quartz.

Value of precious stones produced in 1915.

Montana	$105,355
California	22,312
Nevada	6,333
Colorado	5,987
Arizona	4,998
Oregon	4,252
Utah, New Mexico, Alaska, Virginia, Maine, Arkansas [1]	16,952
Other States [2]	4,242
	170,431

[1] Production of each State more than $1,000 and less than $4,000.

[2] Massachusetts, Michigan, North Carolina, New Hampshire, Idaho, South Dakota, Connecticut, Minnesota, Kansas, Pennsylvania, New York, South Carolina, Texas, Wyoming. Production of each State less than $1,000.

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BERYL.

CALIFORNIA.

Additional samples of blue beryl from a prospect in the Death Valley region of California have been sent to the Survey by Mr. Joseph Ward, of Lone Pine, Cal. The light to dark-blue beryls are practically opaque, the transparent variety having apparently not yet been found.

More or less transparent pink beryls continue to be found in the gem mines at Pala, San Diego County, Cal. Mr. M. M. Sickler has submitted several such crystals that were found during 1915. Similar crystals were also obtained from the Pala Chief mine and the Tourmaline King mine.

CONNECTICUT.

Prof. W. N. Rice, of Wesleyan University, Middletown, Conn., reports the discovery of a beautiful crystal of golden beryl found at East Hampton (formerly Chatham). The crystal is now in the Museum of Wesleyan University.

GEORGIA.

Mr. A. J. Scoggins, of Deweyrose, Ga., reports an abundance of beryl in various places in Elbert County, Ga. About two dozen beryl crystals of an aquamarine blue color have been obtained from a pit 5 feet deep near Antioch Hill mine. Several bushels of fractured deep-blue beryls were picked up on the surface near the Yellow Hill mine, on the north side of Little Broad River about 3 miles from Oglesby on the Seaboard Air Line Railway. Beryl of better quality, suitable for gems, was obtained from several shallow pits in the neighborhood.

MAINE.

Good beryl of gem quality was obtained by Mr. F. H. Peterson, of Fryeburg, Me. Three crystals—8 by 14, 5½ by 14, and 6 by 22 inches—considerably flawed, yielded some gem material. A smaller crystal, several inches long and ⅜-inch thick yielded some good aquamarine. The market for aquamarine is said to have been good.

MASSACHUSETTS.

The Reynolds mine at Beryl Hill, near Royalston, Mass., was again worked by Mr. F. H. Reynolds, of Boston, who obtained a large quantity of aquamarine beryl, of good color and clearness. Some of the material of fine quality yielded cut stones nearly 16 carats in weight. Many fine cabinet specimens were also obtained. The occurrence was described in detail in the report on precious stones in Mineral Resources for 1913. A lot of matrix specimens kindly loaned by Mr. Reynolds showed most of the beryl crystals embedded in a light smoky-gray granular quartz. Other minerals noted were a dark reddish-brown garnet, white feldspar, and mica plates. One small beryl crystal, not of gem quality, was embedded in feldspar. Among the cut stones also submitted by Mr. Reynolds were some very fine ones, of marked brilliancy and beauty of color. A large

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table-cut stone of 15.7 carats, measuring 16 by 13 millimeters, was of an exceptionally fine blue color. Another large stone, measuring 18 by 14 millimeters, weighed 14.2 carats. A smaller table-cut stone, 14 by 11 millimeters, weighing 10 carats, was of an exquisite pale-blue color. A large round cut stone, measuring 14 millimeters across and weighing 12.6 carats, was very brilliant and of fine color.

NORTH CAROLINA.

A beautiful beryl weighing 3 pounds and containing good gem material is reported by Mr. L. A. Gettys, of Shelby, N. C., to have been found in Burke County.

SOUTH CAROLINA.

About 10 pounds of pale blue beryl were obtained by Mr. J. M. McConnell, of Anderson, S. C., from a deposit 3 miles from Anderson. The broken crystals were found on the surface and yielded some cut gems.

CORUNDUM (SAPPHIRE).

Mr. J. M. Robertson, of Bozeman, Mont., reports that an oriental amethyst, as the purple sapphires are called, was found on a bar of Missouri River a few miles from Helena, Mont. When cut the stone weighed 3½ carats. A green sapphire, or oriental emerald of a greenish-yellow color, clear and brilliant, 3 carats cut, was found with it.

The mines of the New Mine Sapphire Syndicate, of London, which are situated in Fergus County, Mont., were operated only to a very small extent and the output was less than in normal times. No new mining operations were reported, the various dumps being washed over.

DIAMOND.

ARKANSAS.

According to Kunz,[1] 32 stones were found by the watchman of the Arkansas Diamond Co. in 1915. These stones were white, yellowish, and brown. Three stones, transparent and perfect, weighed, respectively, 0.32, 1.22, and 2.50 carats. The total weight of the stones found was 17.9 carats.

The Kimberlite Diamond Mining & Washing Co. has been in constant operation, according to Austin Q. Millar, washing ground from the Mauney and the Ozark mines. It is the policy of this company to withhold figures of production, and the values given under the production of diamonds are therefore too small. As soon as the company is in a position to give figures of production, a more accurate statement of the value of the diamonds produced in this country can be given. The other companies in this field have not reported any production. A detailed report of the diamond-bearing area is in preparation by Hugh D. Miser, of the United States Geological Survey, who states that according to reports at least 4,000 stones have been produced up to July 1, 1916.

[1] Kunz, G. F., The production of precious stones for the year 1915: Mineral Industry, vol. 24, p. 608, 1916.

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CALIFORNIA.

Isolated diamonds continue to be found in Cherokee Flat, Butte County. Placer miners washing for gold in the old diggings on ground owned by the United States Diamond Mining Co. found 9 stones in 1915, according to M. J. Cooney, manager of the Forbestown Consolidated Gold Mines, at Forbestown, Cal. Three of the stones averaged 1 carat each and were white and of first quality. The Cherokee ground owned by the United States Development Co. has been left open by the company for all comers to prospect. William Fliedner reports the respective weights of 2 stones found here to be eleven-sixteenths of a carat and one-fourth of a carat.

About 50 diamonds have been found in the Tertiary gravels of the old river channels in and about Smiths Flat, Eldorado County, and Burr Evans, of Placerville, Cal., has furnished a record of these diamonds. Judge W. P. Carpender, an old-time miner and justice of the peace at Placerville, who arrived there in 1854, kept an accurate record of all the diamonds found in Eldorado County, and from his list, supplemented by Mr. Evans's own contribution, the following notes have been taken. The weights given have been changed to metric carats.

In 1859 John Bradshaw found one small white stone in the Buchanan mine, Smiths Flat.

In 1865 John Lyford found one white stone weighing 0.97 metric carat at Smiths Flat, which was set rough in a ring.

In 1866 A. Brooks found one white flawed stone at Spanish Ravine which weighed 0.65 metric carat.

In 1867 Ward Bros. found three small stones near White Rock Canyon, the largest of which was valued at $50 in San Francisco.

In 1868 Thos. Ward & Co. found three stones in the Live Oak mine, Reservoir Hill, two white of medium size and one yellow. One, set in a ring is the possession of Mr. Ashcroft, of Oakland, Cal.

In 1868 Thomas Potts, sr., found near White Rock Canyon one light-yellow stone weighing 0.65 metric carat which was sold to A. W. Goodyear, first mineralogist of the State of California, when he visited the mines at Smiths Flat in 1871.

J. Jeffry found one yellow stone at Webber Hill, weighing 0.97 metric carat. No date given.

In 1868 Mrs. S. Henderson found one white stone of medium size in the Wisconsin Flat Mine.

In 1868 Cruson & Olmstead found four stones in the Wisconsin Flat mine.

In 1869 Henry Olmstead found one stone, $\frac{2}{3\frac{2}{2}}$-inch maximum diameter, weighing 1.82 metric carats, with a white coating on the surface. It sold for $280 in San Francisco.

In 1870 McConnell & Reed found one canary-colored stone the size of a small white bean in a mine on the south side of Webber Hills and the east side of Texas Hill. Mrs. Caleb Reed, of Placerville, now has this stone set in a ring.

Nathaniel O. Ames found one stone weighing 1.30 metric carats in a mine on Webber Hill. No date given. It was set in a ring and worn by Shelly Inch, postmaster at Placerville, for many years. It is now in the possession of L. P. Inch, at 444 California Street, San Francisco.

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Charles W. Schafer found one stone weighing 0.81 metric carat in the Tolkey mine, Texas Hill, which was sold to John Cook. No date given.

In 1878 Frederick Bendfeldt, sr., found one canary-colored stone weighing 0.45 metric carat at Smiths Flat, which was sold to W. F. Alma, of Boston.

In 1879 Edward Randall found one white stone in the Wisconsin Flat mine, which weighed 0.13 metric carat.

In 1894 Frederick Bendfeldt, jr., found one stone weighing 0.96 metric carat, canary color, which was sold to W. F. Alma.

In 1896 Bert Carpender found two white stones weighing, respectively, 1.92 metric carats and 0.26 metric carat; also one canary-colored stone weighing 1.67 metric carats. They were sold to W. F. Alma.

In 1896 Thomas Murdock found one yellow stone weighing 1.07 metric carats at Smiths Flat, which was sold to W. F. Alma.

In 1897 Snow Bros. found one white stone weighing 1.54 metric carats near Newtown.

In 1897 Snow Bros. found one canary-colored stone weighing 0.97 metric carat near Fairplay. It is now in the possession of George Richardson of Placerville.

In 1899 Bert Carpender found one white stone weighing 0.65 metric carat in the Stanley mine, Smiths Flat. It is now in the possession of W. P. Stanley.

In 1900 Frederick Bosworth found one white stone weighing 1.46 metric carats, in Cedar Ravine, at Placerville. Bosworth, of Placerville, still has this stone in the rough and has been offered $80 for it.

In 1901 J. Allen found one white stone in Cedar Ravine, at Placerville, weighing 0.42 metric carat, which was sold to W. F. Alma.

In 1912 Bert Carpender found one white stone weighing 0.97 metric carat, in the Carpender mine, at Prospect Flat.

About 1874 two diamonds were found at Smiths Flat, one weighing 0.10 metric carat, which was purchased by F. F. Barss from a Chinaman, and the other weighing 0.13 metric carat, which was bought by Mr. Barss from a white miner. Mr. Barss is quoted as saying that in the seventies and eighties he mounted five stones in breastpins and two in finger rings for different people, all of which were good diamonds and were found in the vicinity of Smiths Flat. Mr. Barss states that another good stone was found by Henry Ashcroft in 1869.

N. H. Burger says he cut and set in finger rings from 1906 to 1910 five diamonds that were found by different persons in the gravel of the Neocene river channels between Placerville and Smiths Flat. The stones ranged from 0.1 to 1 metric carat, and one was a fine stone of about 0.36 metric carat. About the year 1913 he set in a finger ring for Frank Jones a diamond of about one-half carat, which Jones had found in his gravel in Chile Ravine, just south of Placerville.

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FELDSPAR.

CALIFORNIA.

Mr. Joseph Ward, of Lone Pine, Cal., has sent additional specimens of amazon stone from the Death Valley region of California to the Survey. Some of the smaller pieces show a good color, and it is possible that further exploitation will show larger and deeper-colored material.

Microcline with interlaminated albite (perthite) is found in considerable quantity in the gem mines of San Diego County. The possibilities of cutting this material into cabochon stones, so oriented as to show the albite lamellae to the best advantage, do not seem to have been fully developed.

COLORADO.

The bulk of the feldspar, used as a precious stone, was produced by Colorado, the amazon stone leading all the other feldspars in value. Some gem orthoclase and oligoclase were also produced.

NEW YORK.

Mr. W. G. Levison, of Brooklyn, N. Y., reports that peristerite was found at Valhalla, N. Y., in one of the gneiss quarries from which some of the stone used in building the Kensico dam is obtained. The material seems to form part of a dike, and some of it shows on certain surfaces a beautiful blue sheen by reflected light. Several dozen stones have been cut.

UTAH.

A new find of transparent pale-yellow labradorite is reported by Kunz.[1] The locality is given as Millard County, Utah. The material is said to be similar to that found in the Altar Mountains of Arizona, described in this report for 1914.

GARNET.

ALASKA.

The Alaska Garnet Mining & Manufacturing Co., of Minneapolis, Minn., worked the deposit of garnets near Wrangell, at the mouth of Stikine River. The garnets are thickly distributed through the mica schist, 15 to 25 garnet crystals being often found on a square foot of rock. The largest garnets weigh half a pound. Although the surface stones are badly flawed, gems of fine color and quality are obtained by deep mining. Many were cut in cabochon shapes and a large number of such stones as well as specimens of garnet in the matrix were sold at the San Francisco Exposition.

[1] Kunz, G. F., The production of precious stones for the year 1915: Mineral Industry, vol. 24, p. 611, 1916.

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IDAHO.

A few garnets were sent to Maynard Bixby, of Salt Lake City, Utah, for cutting. The garnets are reported to have come from a locality near Orofino, Nez Perce County, Idaho. The general appearance of the stones suggests spessartite. The garnet pebbles show rounded crystal faces, an unusual feature of garnet pebbles.

MASSACHUSETTS.

Some deep, rich red garnets, about 50 in all, were picked up on the surface of a micaceous schist rock in the Connecticut Valley in northern Massachusetts, not far from the Vermont line. Mr. S. W. Denton, of Boston, Mass., has cut from them perfect gems of 2 carats and larger ones slightly flawed. Apparently no development work has been undertaken.

OTHER STATES.

In addition to the States listed, an appreciable production of garnet was reported from Arizona, Montana, Colorado, California, Arkansas, and North Carolina. Several States not named have probably had a small production of gem garnets whose report has failed to reach the Geological Survey.

OPAL.

Mr. J. B. Kiernan, of Beatty, Nev., reports that massive opal is found in a deposit of diatomaceous earth, the variously colored opals being called by him vermilion (opal impregnated with cinnabar), amber (resinous opal), milky, and radio (smoky color due to organic matter). Some of this opal has been cut and sold.

QUARTZ.

PRODUCTION OF VARIETIES.

A large number of gem stones are varieties of quartz. The crystallized quartz includes amethyst, asteriated or star quartz, aventurine, cat's eye, citrine, dumortierite in quartz, goethite in quartz, gold-quartz, hornblende, actinolite and asbestos in quartz, milky quartz, rock crystal, rose quartz, rutile in quartz, sapphirine-quartz, smoky quartz, and Thetis hairstone.

Under the heading agate are included the compact, dense, granular varieties of quartz that are more or less translucent. The varieties include agate, agatized wood, carnelian, chalcedony, chrysoprase, moss agate, onyx, plasma, prase, rainbow agate, sardonyx, and violite.

Under the heading jasper are included the opaque, dense forms of silica, usually strongly colored by compounds of iron. Their value is largely dependent on the intensity, purity, and arrangement of the colors. The varieties are agate jasper, bloodstone, common jasper, jasperized wood, flint, novaculite, and touchstone.

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Value of quartz gems produced in 1915.

Crystallized quartz (including amethyst and rose quartz)	$2,909
Agate (including chrysoprase)	24,312
Jasper	8,503
	35,724

The value of all the agate gems amounts to about two-thirds of the total value of all quartz or silica gem stones.

AMETHYST.

Amethyst of a good purple color was obtained by J. A. Scoggins, of Deweyrose, Ga., from a prospect near the Antioch mine. A. J. Rudinger, of Trevilians, Va., continued his prospecting in 1915 and after locating the vein took out a large number of crystals, a few of which would yield small gems of a rich purple color. Colorado, North Carolina, and Arkansas reported a production. Some amethyst of gem quality is occasionally found in the trap quarries of New Jersey.

SMOKY QUARTZ.

Associated with the topaz pockets developed by F. H. Peterson, of Fryeburg, Maine, was a quantity of smoky quartz which lined the sides of the pockets. The quartz crystals were of a beautiful dark amber color and about half of them were of gem quality and were cut into different shapes. A production of smoky quartz is also reported from Colorado, California, Arkansas, Arizona, Connecticut, and New Hampshire.

MINERALS INCLOSED IN QUARTZ.

Transparent quartz crystals with included goethite needles were mined near Bakersville, N. C., by W. G. Bowman. The hairlike needles of goethite give a rainbow hue to the specimens. Mr. Maynard Bixby, of Salt Lake City, Utah, reports that a deposit of tourmalinated quartz was found in Nevada, the exact locality not being given. Mr. Roy Carson, of Pasadena, Cal., reports a small production of tourmalinated quartz from the Panama-Pacific Exposition group of three claims on the east side of Chihuahua Valley, San Diego County. Asteriated quartz, gold quartz, and rutilated quartz are additional varieties of quartz inclosing minerals that were produced in 1915.

AGATE.

CALIFORNIA.

An amethystine or violet-colored chalcedony, found east of San Diego, has been put on the local market under the name violite. A specimen of the material was on exhibition in the San Diego Chamber of Commerce during the summer of 1915. The rough material resembles violet-colored chalcedony from other localities, and the cabochon-cut stones can not be told from cloudy amethysts. California continued to produce carnelian, blue, white, and variously colored chalcedony, myrickite, and chrysoprase.

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KANSAS.

Various kinds of agate and chalcedony are found in the gravel beds of the Big Blue River and its branches, on the hillsides near the river in drift, and also on the high prairie. A small production is reported by Mr. Samuel Forter, of Marysville, Kans.

MONTANA.

Considerable quantities of moss agate, mocha stone, and various other agates were found in eastern Montana in the gravel beds along Yellowstone River. The moss agate is found in irregular pieces from 1 ounce to 10 pounds in weight, each piece being individually valued according to its peculiar markings. A set of cut and polished moss agates was sent to the Survey by the Hanson-Kohn Jewelry Co. (now the Kohn Jewelry Co.), of Billings, Mont. Among the best of these were 12 stones, as follows:

1. Size, 21 by 11 millimeters. Resembles a landscape with a few scattered trees; rolling ground, with small hills. Highly translucent chalcedony; brownish-black markings. Mounted as brooch in gold.
2. Size, 28 by 15 millimeters. Looks like woods along shore of river or lake—brush and trees 1–5 millimeters high in perfect likenesses; some in distance. Agate, highly translucent, slightly banded with bluish-gray and brownish-black markings.
3. Size, 32 by 21 millimeters. Shows a landscape with a grove of tall trees like Lombardy poplars; high on right, low like edge of clearing on left. Trees in haze in distance. Brush from 1 millimeter to trees 10 millimeters high; ground line under trees sharp, with some brush. Bluish-gray, slightly banded chalcedony; the trees black; ground brownish black to black.
4. Size, 48 by 21 millimeters. Resembles thicket of small brush and woods, passing into brushy and grassy slope to shore of river or lake on right. Bunch of leaves or tree branches overhanging water on right. Tallest trees, 8 millimeters. Trees in distant haze. Black and brownish markings in highly translucent bluish-gray chalcedony, showing faint bands.
5. Size, 42 by 32 millimeters. Shows brownish-black buffalo head; 28 millimeters sweep across horns, 20 millimeters high; not perfect but easily recognizable. Mounted as fob stone.
6. Size, 50 by 20 millimeters. Two hills, slopes covered with brush of uniform height, 1½ millimeters high. Gully between hills nearly bare of brush. Two small bunches of tree branches overhanging from right corner. Other branches in haze in distance in back. Sky otherwise clear. All markings brown on translucent, bluish-gray chalcedony. No banding.
7. Size, 33 by 20 millimeters. Shows resemblance to sand dune with wide spreading tree on top. Tops of trees appear over hill. Dark-brown color on translucent bluish-gray chalcedony. No banding.
8. Size, 26 by 13 millimeters. Group of ferns, about seven distinct plants, 7–10 millimeter high and 2–3 millimeters wide. Several varieties of structure, evenly arranged. Black to dark brown on translucent bluish-gray chalcedony. No banding.
9. Size, 34 by 19 millimeters. Group of black to dark-brown radiating fern leaves in clear, transparent, light bluish-gray chalcedony. No banding. Three main arms of fern 120° apart, with smaller leaves in between.
10. Size, 33 by 16 millimeters. Resembles a water scene, with clear bluish-gray sky. The water edge marked by wide curving brownish band, with several groups of black trees showing reflection in water. Two small patches of sedge in foreground. Transparent, bluish-gray chalcedony. No banding.
11. Size, 43 by 22 millimeters. "Lonesome pine." A single pine tree, the lower part of trunk clear, the upper brushy and spreading into three distinct layers, black, against faintly banded translucent, bluish-gray chalcedony. The faint banding gives a good cloud effect. Foreground, clear, brown, also faintly banded. A small irregularly shaped dark-brown flaw, to the left and slightly above horizon, somewhat mars an otherwise perfect picture.
12. Size, 32 by 24 millimeters. Water scene. Group of islands, with trees, black to dark brown, the largest 7 millimeters high and 5 millimeters wide. Many small

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islands. In foreground, nearly continuous curved line of small islands, with practically no vegetation higher than sedge grass. Translucent bluish-gray chalcedony. Faintly banded.

NEBRASKA.

Moss agate is found in considerable abundance in northwestern Nebraska.[1] Chalcedony is also found in concretionary and stalactitic form, of a waxy or oily luster and of a yellow color. Some of it has been cut and sold in southeastern Nebraska.

OREGON.

Various agates are found as stream pebbles in Rogue River valley near Medford, in basaltic lava areas—black and brown moss agate, jasper, carnelian, etc. A banded jasper, a clear stone with a small red band shading off into yellow, jasper has been found at Tillamook, near Newport.

JASPER.

ARIZONA.

A variety of agate jasper occurring in irrgeular nodular forms near the rim of the Grand Canyon, Ariz., about 1 mile west of El Tovar Hotel, has been called zonite by S. W. Denton, of Boston, Mass. The name is apparently derived from the State in which it is found and not because of any zonal structure in the material. The material cut in cabochon form has been used by arts and crafts workers. The colors are white, cream, pink, yellow, brown, and plum. The material is hard, close-grained, uniform in texture, and takes a high polish. Samples sent to the Survey in both the rough and the cut forms show a compact chert in which many of the color variations are marked and abrupt, with consequent pleasing color patterns on the polished stone. Most of the colors are in the yellows, brownish reds, and dark grays, with splotches of white and light gray.

Mr. E. A. Howard, of Cave Creek, Ariz., sent in some samples of a red jasper which polishes well and no doubt would make an interesting and handsome semiprecious gem. The material contains numerous concentric rings of specular hematite. Mr. Howard intends to place the material on the Los Angeles market. The material occurs in a small streak in an irregular mass of variously colored jasper, which is found in a large basaltic intrusion in schist. The wavy circular lines of the concentric bands average about a quarter of an inch in diameter. These concentric bands occur isolated and also joined together in small groups. The black lines, due to a concentration of black hematite grains set in a strong hematite-red, make a pretty contrast and if cut with reference to the black circles should make odd and attractive gems.

OTHER STATES.

A large production of kinradite from California is reported. This new gem stone, consisting of small spherulites set in a dense base, is fully described in the report on precious stones in Mineral Resources for 1913. Colorado, Arkansas, Nevada, and North Carolina also report a production of jasper, the varieties including bloodstone, Lydian stone, novaculite, and agatized and petrified wood.

[1] Barbour, E. H., Nebraska minerals which excite common inquiry: Nebraska Geol. Survey Leaflet 37, vol. 4, pt. 20, p. 269 (no date).

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RHODONITE.

OREGON.

A vein of rhodonite 4 feet wide is reported by Mr. D. B. Bubar, of Roseburg, Oreg., to have been found near the caves on Caves Creek, Josephine County. Preliminary work showed considerable material available and slabs 6 by 8 inches could be obtained. The rhodonite is said to be of good quality and to take a fine polish.

STAUROLITE.

MINNESOTA.

Mr. T. C. Wing, of St. Cloud, Minn., has sent in samples of staurolite from the banks of the Mississippi about 25 miles north of St. Cloud and about 3 miles from Royalton. Many of the crystals are twinned so as to form the usual crosses, but perfect ones are not common. The crystals, as much as an inch in length, are found loose in the soil, in a blue clay, and also in the schist matrix. Bowlders 3 feet thick contain numbers of the crystals. The mineral is dark brown and unaltered, and therefore too hard to be finished off smoothly for the jewelry trade like the similar stones from Virginia.

VIRGINIA.

The staurolites, better known as "fairy stones," are found in a field of about 50 acres on top of Bull Mountain, Patrick County, and have a ready sale. These "fairy" or "lucky" stones are twinned staurolite crystals simulating the Roman, Maltese, and St. Andrew's crosses. They are as much as an inch in length and are of a dark-brown color. The original staurolite mineral has changed to a compact softer material, so that the stones can readily be prepared for the jewelry trade. A brisk trade in these popular stones is reported; they are mounted as cuff links, scarfpins, brooches, charms, and in many other ways.

THOMSONITE.

An occurrence of thomsonite in an amygdaloidal rock in Cook County, Minn., about 7 miles from Grand Marais, has been worked by Alfred Merritt, of Duluth, Minn. A number of stones of gem quality are said to have been obtained, and Mr. Merritt intends soon to mine and market the stones. The colors vary from a light yellow or brown to a dark green, with many intermediate shades. Those stones which are cut so as to show a central eye are in good demand, being used for settings in scarfpins, cuff links, brooches, etc.

The mineral is also reported from Lane County, Oreg., in a road cut 100 yards west of Deerhorn; also in the gravel of Willamette and McKenzie Rivers, near Eugene.

TOPAZ.

Mr. H. C. Gordon, of San Diego, Cal., reports that about 30 crystals of bluish topaz, some of them containing gem material, were taken from the Mountain Lily mine, near Oak Grove, San Diego County.

Several pockets of topaz crystals were opened by F. H. Peterson, of Fryeburg, Maine. The topaz was scattered through the black dirt in

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the bottom of the pocket. In addition to California and Maine, Colorado and Texas reported a small output of topaz.

TOURMALINE.

CALIFORNIA.

Bluish-green tourmaline, of a color called Nile green, was produced from the Mountain Lily mine near Oak Grove, San Diego County. These tourmalines have been given the trade name of emeralite by J. W. Ware, of San Diego. The Peter Cabat mine, about 6 miles north of Warners, Hot Springs, has produced some good blue and light-pink tourmalines. In a newly developed mine south of Banner, San Diego County, Bert Simmons, of Oak Grove, has obtained green tourmalines of gem quality. Some green crystals of good color and gem value, together with some deep blue ones, were obtained by Roy Carson, of Pasadena, from the Panama-Pacific Exposition group of three claims on the east side of Chihuahua Valley, San Diego County.

MAINE.

Fine pink and green tourmalines were found near Georgetown. The Mount Apatite mines, near Auburn, and deposits at Paris have yielded some tourmaline and beryl.

TURQUOISE.

Turquoise ranks third in the value of precious stones produced in 1915, tourmaline being very nearly of equal value. Nevada, New Mexico, and Arizona produced the bulk of the turquoise.

A new deposit of turquoise was discovered in the fall of 1915 by J. H. Malloy, of Rawhide, Nev. The locality is reported as being near Rand, about 18 miles south of Rawhide.

VESUVIANITE (CALIFORNITE).

A small quantity of californite was extracted from the deposits at Big Bar, Butte County, Cal. The color and quality are steadily increasing as the workings descend from the surface, the material becoming dark green with darker green spots. A production was also reported from Happy Camp, Siskiyou County.

ZOISITE (THULITE).

Mr. A. C. Taylor, of Seattle, Wash., reports that a ledge in Okanogan County contains a large amount of rose-red stone pronounced to be thulite, a variety of the mineral zoisite. The deposit is apparently to be worked by the Thulite Association Claims, 427 L. C. Smith Building, Seattle, Wash.

IMPORTS.

The value of the imports of precious stones into the United States during the calendar year 1915 as reported by the Bureau of Foreign and Domestic Commerce, amounted to $26,193,862, an increase of $6,982,778 over 1914, which was the smallest since 1908.

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Diamonds and other precious stones imported and entered for consumption in the United States, 1906–1915.

Year.	Diamonds.					Diamonds, and other stones not set.	Pearls.	Total.
	Glaziers.	Dust or bort.	Rough or uncut.	Set.	Unset.			
1906	$104,407	$150,872	$11,676,529	$305	$25,268,917	$3,995,865	$2,405,581	$43,602,476
1907	410,524	199,919	8,311,912	.....	18,898,336	3,365,902	680,006	31,866,599
1908	650,713	180,222	1,636,798	.....	9,270,225	[a] 1,051,747	910,699	13,700,404
1909	758,865	50,265	8,471,192	.....	27,361,799	[a] 3,570,540	24,848	40,237,509
1910	213,701	54,701	9,212,378	.....	25,593,641	4,003,978	1,626,083	40,704,487
1911	199,930	110,434	9,654,219	.....	25,676,302	3,795,175	1,384,376	40,820,430
1912	452,810	94,396	9,414,514	.....	22,865,686	3,405,543	5,130,376	41,363,325
1913	471,712	100,704	12,268,543	.....	24,812,604	2,775,811	5,002,624	45,431,998
1914	579,332	77,408	2,851,933	.....	11,976,871	1,635,522	2,090,018	19,211,084
1915	366,793	75,944	7,020,646	.....	13,169,998	1,046,572	4,513,909	26,193,862

[a] Including agates. Agates in 1906, $20,130; in 1907, $22,644.

FOREIGN GEM INDUSTRY.

The foreign governmental regulations, trade conditions, market, imports, and production in regard to diamonds, resulting from the European war, are described in detail by Kunz,[1] who also gives notes on emerald and deep-blue beryl from Brazil, jade from Burma, opal (said to be noble opal) from South Australia, sapphire from Queensland, and turquoise from Lower California. The sapphire-mining industry of Anakie, Queensland, is said[2] to have been the dullest on record, the output for 1915 being £600, compared with £15,000 in 1914 and £43,292 in 1913.

The diamond output of British Guiana for 1915 was 100,522 stones, weighing 13,716½ carats and valued at £28,576. The stones averaged 7.32 to a carat.

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CLAY-WORKING INDUSTRIES.[1]

By JEFFERSON MIDDLETON.

GENERAL CONDITIONS.

This report deals with the products of the clay-working industries as well as with clay mining, and the tables are made up to show the output of manufactured clay products as best expressing the production of clay.

The year 1915 in the clay-working industries was not one of general prosperity. The total value of all clay products marketed was $163,120,232, compared with $164,986,983 in 1914, a decrease of about 1 per cent. This decrease, however, was only about one-tenth as great as that of 1914, compared with 1913, and seems to indicate that the depression of the last two years is passing and that the future is more promising. During the later part of 1915 business was very much better than in the early months, and the year closed with business good, so that the prospects are that 1916 will be one of the most prosperous years in the history of these industries.

Of the two great divisions of the industry—(1) brick and tile and (2) pottery—the former showed a decrease and the latter showed an increase in value. The decrease in value of brick and tile was $3,793,978, or nearly 3 per cent; the increase in pottery was $1,927,227, or more than 5 per cent.

The most prominent features in the industries were (1) the large increase in production and the even larger increase in value of common brick in Cook County, Ill.—the production in 1915 (739,173,000 brick) made it the rival of the New York portion of the Hudson River region, the output of Cook County being less in quantity by only 2,395,000 brick and greater in value by more than $1,000,000; (2) the large increase in production and value of fire brick; (3) the increase in value of front brick; (4) the large increase in value of clay products in Illinois and Pennsylvania; (5) the large decrease in value of sewer pipe; and (6) the small increase in average price per thousand of common brick and the decrease in average price of other varieties of brick. The engineering and refractory products, vitrified brick, draintile, sewer pipe, stove lining, and fire brick showed a net decrease in value of $317,020 and the clay structural materials showed a net decrease of $4,028,088 in 1915 compared with 1914.

In the brick and tile industry increase was shown in quantity of vitrified, front, and fire brick marketed and decrease in quantity of common brick marketed in 1915.

[1] The tables of production and building operations in this report have been prepared by Miss Belle Worth Bagley and Miss K. W. Cottrell, and the tables of imports and exports by J. A. Dorsey.

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In the pottery industry every variety of ware, as classified in this report, except china, increased in value. The decrease in the value of china was only about 2 per cent. The value of pottery produced in 1915 was exceeded only in 1913. The imports of pottery in 1915 showed a large decrease, and the proportion of domestic production to consumption—86 per cent—was the largest recorded.

In their statements to the Geological Survey the producers report quantities for common brick, front brick, vitrified brick or block, fire brick, and silica fire brick, but not for fancy brick or for enameled brick. The average price per thousand for common brick increased 3 cents, and the average price for the other varieties decreased—vitrified brick 59 cents, front brick 32 cents, and fire brick 57 cents. No brick and tile product attained its maximum value in 1915, though front brick reached its maximum quantity in that year.

Clay products, except the highest grade, are made principally for local consumption, their low value preventing transportation for any considerable distances. Hence none but the highest grades of ware, principally pottery, are imported, and the European war has had but little direct effect on the brick and tile industries. Some of these wares, however, have been made from imported clays, especially the high-grade fire clays from Germany, and the decrease in the imports of these clays has seriously affected the manufacture of crucibles and lead pencils, as mentioned in the section on clay in this report.

ACKNOWLEDGMENTS.

The writer again desires to thank the clay workers of the country for their cooperation, without which this report would be impossible. Thanks are also extended to the clay-working press for its support and appreciation and to the officials who have supplied information concerning the building operations of the larger cities of the country.

PRODUCTION.

PRODUCTION BY STATES.

The value of the brick and tile products as classified in this report continues to form approximately four-fifths and that of the pottery products one-fifth of the total, though the pottery products have been gradually increasing in late years. Every State is a producer of clay wares. Of the Territories, Alaska and Hawaii reported none for 1915. A small production was reported from the District of Columbia and from Porto Rico. In Nevada and Rhode Island there were not a sufficient number of producers reporting to permit the publication of State totals without disclosing confidential information, so that statistics for these States have been combined with those of contiguous States.

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Value of the products of clay in the United States in 1914 and 1915.

State or Territory.	1914			1915		
	Brick and tile.	Pottery.	Total.	Brick and tile.	Pottery.	Total.
Alabama	$1,557,481	$16,542	$1,574,023	$1,177,725	$15,297	$1,193,022
Arizona	156,167	.....	156,167	97,208	.....	97,208
Arkansas	432,586	19,400	451,986	323,682	20,285	343,967
California	4,116,358	345,303	4,461,661	3,231,281	368,094	3,599,375
Colorado	1,082,685	61,257	1,143,942	1,202,220	62,885	1,265,105
Connecticut and Rhode Island	1,229,037	(a)	1,229,037	1,518,773	(a)	1,518,773
Delaware	154,718	.....	154,718	145,694	.....	145,694
District of Columbia	148,866	(b)	148,866	131,134	(b)	131,134
Florida	240,094	.....	240,094	203,414	.....	203,414
Georgia	2,242,073	20,961	2,263,034	1,826,842	18,177	1,845,019
Idaho and Nevada	110,864	.....	110,864	128,382	.....	128,382
Illinois	12,538,374	780,579	13,318,953	13,843,046	948,892	14,791,938
Indiana	6,503,207	1,152,078	7,655,285	5,892,596	1,198,034	7,090,630
Iowa	6,368,995	32,750	6,401,745	6,738,190	5,425	6,743,615
Kansas	1,905,961	(b)	1,905,961	2,110,877	(b)	2,110,877
Kentucky	2,286,980	89,426	2,376,406	2,332,451	108,839	2,441,290
Louisiana	422,062	(b)	422,062	385,002	(b)	385,002
Maine	914,808	(b)	914,808	488,079	(b)	488,079
Maryland	1,640,017	206,483	1,846,500	1,369,738	206,718	1,576,456
Massachusetts	1,462,453	219,104	1,681,557	1,399,371	184,233	1,583,604
Michigan	2,434,872	265,194	2,700,066	2,248,068	521,989	2,770,057
Minnesota	1,944,886	(b)	1,944,886	1,645,913	(b)	1,645,913
Mississippi	515,797	15,060	530,857	351,929	15,690	367,619
Missouri	6,074,340	2,944	6,077,284	5,428,403	3,166	5,431,569
Montana	440,519	(b)	440,519	524,575	(b)	524,575
Nebraska	640,955	(b)	640,955	776,899	(b)	776,899
New Hampshire	398,066	(b)	398,066	484,464	(b)	484,464
New Jersey	8,353,296	8,131,356	16,484,652	7,916,080	8,049,338	15,965,418
New Mexico	205,914	.....	205,914	240,847	.....	240,847
New York	6,923,141	2,155,792	9,078,933	7,047,262	2,441,740	9,489,002
North Carolina	1,447,994	12,796	1,460,790	1,078,541	11,394	1,089,935
North Dakota	266,046	.....	266,046	189,355	.....	189,355
Ohio	21,815,392	15,351,376	37,166,768	20,909,842	15,929,779	36,839,621
Oklahoma	786,314	.....	786,314	996,451	.....	996,451
Oregon	560,371	(b)	560,371	341,243	(b)	341,243
Pennsylvania	20,100,495	1,746,501	21,846,996	20,898,282	1,827,749	22,726,031
Porto Rico	5,974	.....	5,974	4,193	(b)	4,193
South Carolina	557,977	10,668	568,645	370,152	8,981	379,133
South Dakota	57,711	.....	57,711	36,342	.....	36,342
Tennessee	1,449,120	97,195	1,546,315	1,441,831	106,389	1,548,220
Texas	2,220,240	58,747	2,280,987	1,911,501	65,389	1,976,890
Utah	676,142	(b)	676,142	699,962	(b)	699,962
Vermont	75,847	.....	75,847	71,642	.....	71,642
Virginia	1,472,348	(b)	1,472,348	1,447,802	(b)	1,447,802
Washington	1,809,491	(b)	1,809,491	1,454,436	(b)	1,454,436
West Virginia	1,830,947	3,930,464	5,761,411	1,773,904	4,510,623	6,284,527
Wisconsin	943,999	7,000	950,999	902,199	8,359	910,558
Wyoming	64,942	.....	64,942	57,021	.....	57,021
Other States	.....	669,185	669,185	.....	687,923	687,923
	129,588,822	35,398,161	164,986,983	125,794,844	37,325,388	163,120,232
Percentage of total	78.54	21.46	100.00	77.12	22.88	100.00

a Produced by Connecticut alone, and included in "Other States." b Included in "Other States."

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Value of the clay products of the United States in 1914 and 1915, and increase or decrease in 1915, by States and Territories.

State or Territory.	1914	1915	Increase or decrease in 1915.	
			Value.	Per cent.
Alabama	$1,574,023	$1,193,022	— $381,001	—24.21
Arizona	156,167	97,208	— 58,959	—37.75
Arkansas	451,986	343,967	— 108,019	—23.90
California	4,461,661	3,599,375	— 862,286	—19.33
Colorado	1,143,942	1,265,105	+ 121,163	+10.59
Connecticut and Rhode Island	1,229,037	1,518,773	+ 289,736	+23.57
Delaware	154,718	145,694	— 9,024	— 5.83
District of Columbia	148,866	131,134	— 17,732	—11.91
Florida	240,094	203,414	— 36,680	—15.28
Georgia	2,263,034	1,845,019	— 418,015	—18.47
Idaho and Nevada	110,864	128,382	+ 17,518	+15.80
Illinois	13,318,953	14,791,938	+1,472,985	+11.06
Indiana	7,655,285	7,090,630	— 564,655	— 7.38
Iowa	6,401,745	6,743,615	+ 341,870	+ 5.34
Kansas	1,905,961	2,110,877	+ 204,916	+10.75
Kentucky	2,376,406	2,441,290	+ 64,884	+ 2.73
Louisiana	422,062	385,002	— 37,060	— 8.78
Maine	914,808	488,079	— 426,729	—46.65
Maryland	1,846,500	1,576,456	— 270,044	—14.62
Massachusetts	1,681,557	1,583,604	— 97,953	— 5.83
Michigan	2,700,066	2,770,057	+ 69,991	+ 2.59
Minnesota	1,944,886	1,645,913	— 298,973	—15.37
Mississippi	530,857	367,619	— 163,238	—30.75
Missouri	6,077,284	5,431,569	— 645,715	—10.63
Montana	440,519	524,575	+ 84,056	+19.08
Nebraska	640,955	776,899	+ 135,944	+21.21
New Hampshire	398,066	484,464	+ 86,398	+21.70
New Jersey	16,484,652	15,965,418	— 519,234	— 3.15
New Mexico	205,914	240,847	+ 34,933	+16.96
New York	9,078,933	9,489,002	+ 410,069	+ 4.52
North Carolina	1,460,790	1,089,935	— 370,855	—25.39
North Dakota	266,046	189,355	— 76,691	—28.83
Ohio	37,166,768	36,839,621	— 327,147	— .88
Oklahoma	786,314	996,451	+ 210,137	+26.72
Oregon	560,271	341,243	— 219,028	—39.09
Pennsylvania	21,846,996	22,726,031	+ 879,035	+ 4.02
Porto Rico	5,974	4,193	— 1,781	—29.81
South Carolina	568,645	379,133	— 189,512	—33.33
South Dakota	57,711	36,342	— 21,369	—37.03
Tennessee	1,546,315	1,548,220	+ 1,905	+ .12
Texas	2,280,987	1,976,890	— 304,097	—13.33
Utah	676,142	699,962	+ 23,820	+ 3.52
Vermont	75,847	71,642	— 4,205	— 5.54
Virginia	1,472,348	1,447,802	— 24,546	— 1.67
Washington	1,809,491	1,454,436	— 355,055	—19.62
West Virginia	5,761,411	6,284,527	+ 523,116	+ 9.08
Wisconsin	950,999	910,558	— 40,441	— 4.25
Wyoming	64,942	57,021	— 7,921	—12.20
Other States	[a] 669,185	[a] 687,923	+ 18,738	+ 2.80
	164,986,983	163,120,232	—1,866,751	— 1.13

[a] Includes pottery products which could not be separately classified without disclosing individual figures.

Of the totals for States and Territories represented in this table, 30 showed decrease in the value of clay products marketed in 1915 and 18 showed increase. Illinois, on account of its large production of common brick, showed the largest actual increase. The largest proportionate increase was in Oklahoma, nearly 27 per cent. The largest decrease was in California and the largest proportionate decrease was in Maine, nearly 50 per cent. Of the States showing increase, 2 were in New England, 2 in the Eastern States, 4 in the Southern States, 5 in the Western States, and 5 in the Rocky Mountain States. Twelve States that showed decrease in 1914 rallied and showed increase in 1915, and 5 States that showed increase in 1914 decreased in 1915.

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Value of the clay products of the United States in 1914 and 1915 and increase or decrease in 1915, by products.

Product.	1914	1915	Increase or decrease in 1915.	
			Value.	Per cent.
Common brick	$43,769,524	$42,145,292	−$1,624,232	− 3.71
Vitrified brick or block	12,500,866	12,230,899	− 269,967	− 2.16
Front brick	9,289,623	9,535,536	+ 245,913	+ 2.65
Fancy or ornamental brick	124,459	109,425	− 15,034	−12.08
Enameled brick	1,075,026	835,808	− 239,218	−22.25
Drain tile	8,522,039	8,879,364	+ 357,225	+ 4.19
Sewer pipe	14,014,767	11,259,349	− 2,755,418	−19.66
Architectural terra cotta	6,087,652	4,796,062	− 1,291,590	−21.22
Fireproofing	8,385,337	7,800,938	− 584,399	− 6.97
Tile (not drain)	5,705,583	5,186,055	− 519,528	− 9.11
Stove lining	520,585	459,341	− 61,244	−11.76
Fire brick	16,427,547	18,839,931	+ 2,412,384	+14.68
Miscellaneous	3,165,814	3,716,944	+ 551,130	+17.41
Total brick and tile	129,588,822	125,794,844	− 3,793,978	− 2.93
Total pottery	35,398,161	37,325,388	+ 1,927,227	+ 5.44
Grand total	164,986,983	163,120,232	− 1,866,751	− 1.13

This table shows decrease in ten of the brick and tile products in 1915 and increase in three varieties and in miscellaneous products. As fire brick is used principally in the iron and steel industries and in making coke, the marketed production naturally rises and falls with the output of these materials; it showed a large increase in quantity and value in 1915 over 1914. Drain tile and front brick were the other products that showed increase, the former being due principally to the large increase ($621,763) in Iowa, the leading State in the production of this material. The increase in the value of front brick, though small, indicates the extended use of this material not only in the large office buildings, but in the smaller buildings, frequently as a facing for hollow tile or block.

In 1914 only two varieties of brick and tile products increased in value, vitrified brick and fancy brick, so that, in spite of the net decrease in value of brick and tile products, the general condition appears to be more encouraging than in 1914, when the net decrease in value of brick and tile products was $13,707,935, or nearly 10 per cent.

The pottery industry, on the other hand, was in a much more satisfactory condition than the brick and tile industries and showed a considerable increase over 1914.

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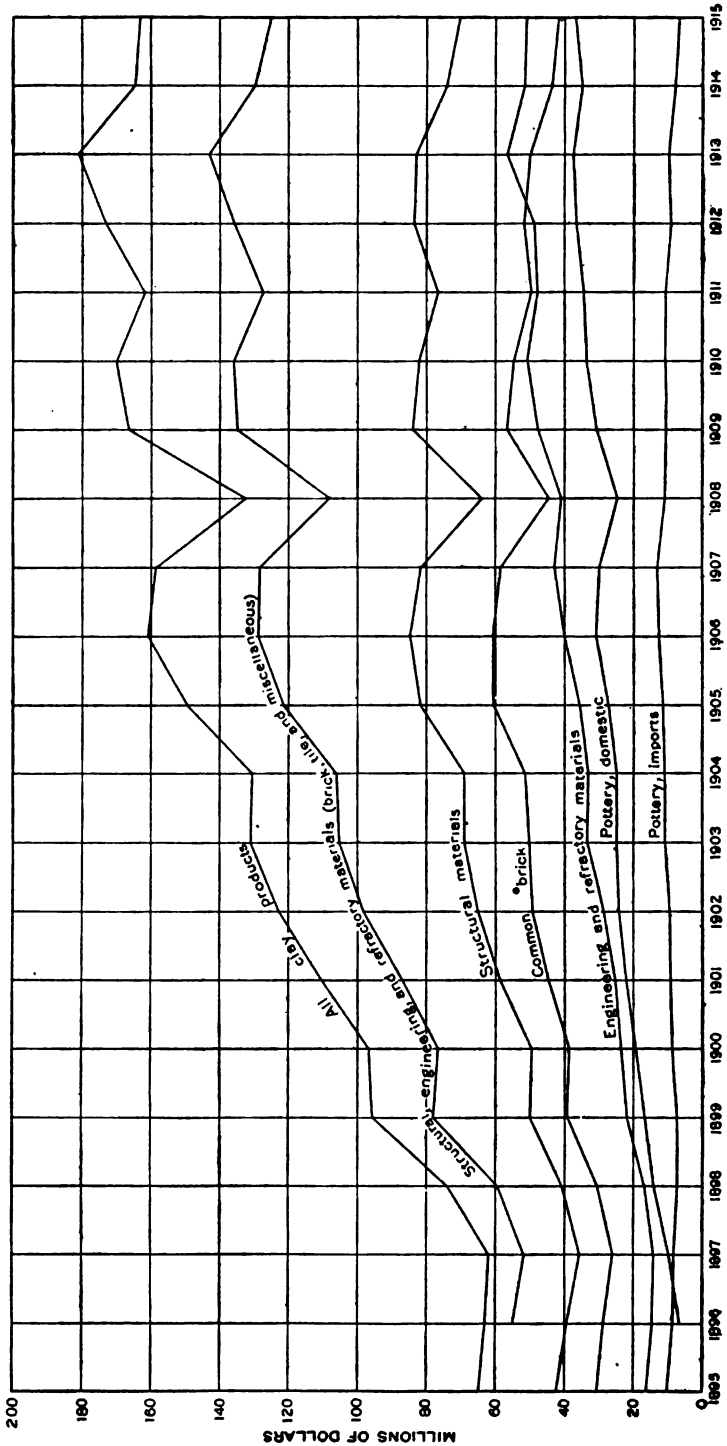

FIGURE 28.—Value of clay products sold in the United States, 1895–1915.

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Clay products sold in the United States, 1895–1915.

Year.	Number of firms reporting sales.	Common brick.			Vitrified brick or block.		
		Quantity (thousands).	Value.	Average price per thousand.	Quantity (thousands).	Value.	Average price per thousand.
1895	.....	6,017,065	$31,569,126	$5.25	381,591	$3,130,472	$8.20
1896	5,293	5,703,379	29,664,043	5.20	320,407	2,794,585	8.72
1897	5,424	5,292,532	26,430,207	4.99	435,851	3,582,037	8.22
1898	5,971	5,867,415	30,980,704	5.28	474,419	4,016,822	8.47
1899	6,962	7,695,305	39,887,522	5.18	580,751	4,750,424	8.18
1900	6,475	7,140,022	38,621,514	5.41	546,679	4,764,124	8.71
1901	6,421	8,038,579	45,503,076	5.66	605,077	5,484,134	9.06
1902	6,046	8,475,067	48,885,869	5.77	617,192	5,744,530	9.31
1903	6,034	8,463,683	50,532,075	5.97	654,499	6,453,849	9.86
1904	6,108	8,665,171	51,768,558	5.97	735,489	7,557,425	10.28
1905	5,925	9,817,355	61,394,383	6.25	665,879	6,703,710	10.07
1906	5,857	10,027,039	61,300,696	6.11	751,974	7,857,768	10.45
1907	5,536	9,795,098	58,785,461	6.00	876,245	9,654,282	11.02
1908	5,328	7,811,046	44,765,614	5.73	978,122	10,657,475	10.90
1909	5,068	9,791,870	57,251,115	5.85	1,023,654	11,269,586	11 01
1910	4,915	9,221,517	55,219,551	5.99	968,000	11,004,666	11.37
1911	4,628	8,475,277	49,885,262	5.89	948,758	11,115,742	11.72
1912	4,284	8,555,238	51,796,266	6.05	911,869	10,921,575	11.98
1913	4,065	8,088,790	50,134,757	6.20	958,680	12,138,221	12.66
1914	3,860	7,146,571	43,769,524	6.12	931,324	12,500,866	13.42
1915	3,636	6,851,099	42,145,292	6.15	963,335	12,230,899	12.83

Year.	Front brick.			Fancy or ornamental brick (value).	Enameled brick (value).	Fire brick (value).	Stove lining (value).	Draintile (value).
	Quantity (thousands).	Value.	Average price per thousand.					
1895	339,204	$4,399,367	$12.97	$652,519	(a)	$5,279,004	(b)	$3,450,961
1896	270,335	3,390,941	12.54	763,140	(a)	4,944,723	(b)	2,613,513
1897	310,918	3,855,033	12.40	685,048	(a)	4,094,704	(b)	2,623,305
1898	295,833	3,572,385	12.08	358,372	$279,993	6,093,071	(b)	3,115,318
1899	438,817	4,767,343	10.86	476,191	329,969	8,641,882	$416,235	3,682,394
1900	344,516	3,864,670	11.09	289,698	323,630	9,830,517	462,541	2,976,281
1901	415,343	4,709,737	11.34	372,131	463,709	9,870,421	423,371	3,143,001
1902	458,391	5,318,008	11.60	335,290	471,163	11,970,511	630,924	3,506,787
1903	433,016	5,402,861	12.48	328,387	569,689	b14,062,369	(b)	4,639,214
1904	434,351	5,560,131	12.80	300,233	545,397	11,167,072	(b)	5,348,555
1905	541,590	7,108,092	13.12	293,907	636,279	12,735,404	645,432	5,850,210
1906	617,469	7,895,323	12.79	207,119	773,104	14,206,868	743,414	6,543,289
1907	585,943	7,329,360	12.51	361,243	918,173	14,946,045	627,647	6,864,162
1908	584,482	6,935,600	11.87	259,556	660,862	10,696,216	529,976	8,661,476
1909	816,164	9,712,219	11.90	174,073	993,902	16,620,686	423,583	9,799,158
1910	697,857	8,590,057	12.31	179,505	832,225	18,111,474	503,806	10,389,822
1911	724,911	8,648,877	11.93	177,015	1,038,865	16,074,686	614,116	8,826,314
1912	814,007	9,455,297	11.62	225,367	1,027,314	17,877,629	516,874	8,010,250
1913	827,665	9,614,138	11.62	109,703	1,225,708	20,627,122	535,667	8,558,320
1914	810,395	9,289,623	11.46	124,459	1,075,026	16,427,547	520,585	8,522,039
1915	855,668	9,535,536	11.14	109,425	835,808	18,839,931	459,341	8,879,264

Year.	Sewer pipe (value).	Architectural terra cotta (value).	Fireproofing (value).	Tile, not drain (value).	Miscellaneous (value).	Total brick and tile (value).	Pottery (value).	Total (value).
1895	$4,482,577	$2,512,193	$741,626	$2,572,628	$6,619,333	.....	(c)	$65,409,806
1896	4,588,503	2,359,983	1,706,504	1,618,127	1,210,719	$55,654,781	$7,455,627	63,110,408
1897	4,069,534	1,841,422	1,979,259	1,476,638	1,413,595	52,050,782	10,309,209	62,359,991
1898	3,791,057	2,043,325	1,900,642	1,746,024	2,000,743	59,898,456	14,589,224	74,487,680
1899	4,560,334	2,027,532	1,665,066	1,276,300	6,065,928	78,547,120	17,250,250	95,797,370
1900	5,842,562	2,372,568	1,820,214	2,349,420	2,896,036	76,413,775	19,798,570	96,212,345
1901	6,736,969	3,367,982	1,860,269	2,867,659	2,945,268	87,747,727	22,463,860	110,211,587
1902	7,174,892	3,526,906	3,175,593	3,622,863	3,678,742	98,042,078	24,127,453	122,169,531
1903	8,525,369	4,672,028	3,861,343	3,505,329	3,073,856	105,626,369	25,436,052	131,062,421
1904	9,187,423	4,107,473	3,629,101	3,023,428	3,669,282	105,864,978	25,158,270	131,023,248
1905	10,097,089	5,003,158	4,098,793	3,647,726	3,564,111	121,778,294	27,918,894	149,697,188
1906	11,114,967	5,739,460	4,586,538	4,634,898	3,988,394	129,591,838	31,440,884	161,032,722
1907	11,482,845	6,026,977	4,250,618	4,551,881	3,000,201	128,798,895	30,143,474	158,942,369
1908	11,003,731	4,577,367	3,168,037	3,877,780	2,268,517	108,062,207	25,135,555	133,197,762
1909	10,322,324	6,251,625	4,466,708	5,291,963	2,694,821	135,271,772	31,049,441	166,321,213
1910	11,428,696	6,976,771	5,110,597	5,240,644	2,743,482	136,331,296	33,784,678	170,115,974
1911	11,454,616	6,017,801	5,660,172	5,356,184	2,847,971	127,717,621	34,518,560	162,236,181
1912	12,147,677	8,580,436	7,174,148	5,809,495	2,764,783	136,307,111	36,504,164	172,811,275
1913	14,872,103	7,733,306	8,620,216	6,109,180	3,018,316	143,296,757	37,992,375	181,289,132
1914	14,014,767	6,087,652	8,385,337	5,705,583	3,165,814	129,588,822	35,398,161	164,986,983
1915	11,259,349	4,796,062	7,800,938	5,186,055	3,716,944	125,794,844	37,325,388	163,120,232

a Enameled brick not separately classified prior to 1898.
b Stove lining not separately classified prior to 1899, is included in fire brick in 1903; in miscellaneous in 1904.
c Pottery, unclassified in 1895, is included in miscellaneous in that year.

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The growth of the clay-working industries during the last 21 years is shown in this table. The total value of the products ranged from $62,359,991 in 1897 to $181,289,132 in 1913, an increase in 1913 over 1897 of $118,929,141, or 191 per cent. The increase in 1915 over 1897 was $100,760,241, or 162 per cent. The value in 1915 was $884,051 greater than that of 1911 and $29,922,470 greater than that of 1908, the year of greatest decrease, and was exceeded by only five other years, 1909, 1910, 1912, 1913, and 1914. In the period covered by the table decreases are recorded for only eight years—1896, 1897, 1904, 1907, 1908, 1911, 1914, and 1915. The greatest decrease was in 1908—$25,744,607, or 16 per cent. The greatest increase was in 1909—$33,123,451, or 25 per cent.

The maximum quantity of common brick was reached in 1906 and the maximum value in 1905. The production in 1915 was less by 3,175,940,000 brick, or 32 per cent, than the maximum and was the smallest output since 1898. The value of common brick in 1915 was less than the maximum by $19,249,091, or 31 per cent, and was the lowest since 1900.

Vitrified brick reached its maximum quantity in 1909 and its maximum value in 1914. The output in 1915 was less by 70,319,000 brick, or 7 per cent, than the maximum.

Front or face brick reached its maximum quantity in 1915 and its maximum value in 1909. Its value in 1915 was less than the maximum by $176,683, or 2 per cent.

The use of fancy or ornamental brick continues to decline. The value of this product was the lowest reported and was less by $653,715 than the maximum in 1896.

Enameled brick reached its maximum value in 1913 and decreased in 1914 and 1915, the value of the output in the latter year being less by $389,900, or 32 per cent, than the maximum.

The fire-brick industry has shown a remarkable growth; the value has increased more than threefold in the last 21 years. It attained its maximum value in 1913. The output of 1915 was less by $1,787,191, or 9 per cent, than the maximum.

The value of draintile in 1915 was exceeded only in 1909 and 1910. The decrease in 1915 compared with 1910 was $1,510,558, or 15 per cent.

Sewer-pipe industry has shown a large growth since statistics of the clay-working industries were first compiled by the United States Geological Survey, but has decreased greatly during the last two years. It reached its maximum value in 1913. The value in 1915 was less by $3,612,754, or 24 per cent, and was the smallest since 1909.

Terra cotta reached its maximum value in 1912. It has decreased considerably each year since that date, the product in 1915 being less by $3,784,374, or 44 per cent.

Fireproofing, which increased rapidly in value from 1908 to 1913, reaching its maximum in that year, has been declining in value since. Its value in 1915 was less by $819,278, or nearly 10 per cent, than the maximum.

Tile, not drain, which embraces all varieties of tile except draintile, reached its maximum value in 1913 and has shown considerable decrease since, its value for 1915 being less by $923,125, or 15 per cent, than the maximum.

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RANK OF STATES.

Ohio has been the leading State in the value of clay products since the statistics were first compiled by the Survey in 1894. The value of its output has always greatly exceeded that of the second State, Pennsylvania, and in 1915 this excess was $14,113,590, or 62 per cent. New Jersey ranked third. There was no change in the relative rank of the first seven States. West Virginia rose from ninth in 1914 to eighth in 1915, exchanging places with Missouri. Kansas rose from sixteenth to thirteenth. Connecticut and Rhode Island (taken together) rose from twenty-fourth to twentieth, Montana from thirty-fifth to thirtieth, and New Hampshire from thirty-seventh to thirty-second. The first 10 States reported wares for 1915 valued at $128,961,726, or 79 per cent of the total; for 1914 the same States reported wares valued at $128,253,688, or 77 per cent of the total. The first five States reported wares in 1915 valued at $99,812,010, or 61 per cent of the total, compared with $97,897,302, or 59 per cent of the total, in 1914.

Rank of State, value of output, and percentage of total value of clay products in 1914 and 1915.

State or Territory.	1914				1915			
	Rank.	Number of firms reporting sales.	Value.	Percentage of total value.	Rank.	Number of firms reporting sales.	Value.	Percentage of total value.
Ohio	1	543	$37,166,768	22.53	1	524	$36,839,621	22.58
Pennsylvania	2	369	21,846,996	13.24	2	352	22,726,031	13.93
New Jersey	3	148	16,484,652	9.99	3	149	15,965,418	9.79
Illinois	4	263	13,318,953	8.07	4	247	14,791,938	9.07
New York	5	205	9,078,933	5.50	5	192	9,489,002	5.82
Indiana	6	240	7,655,285	4.64	6	221	7,090,630	4.35
Iowa	7	171	6,401,745	3.88	7	161	6,743,615	4.13
West Virginia	9	58	5,761,411	3.49	8	58	6,284,527	3.85
Missouri	8	98	6,077,284	3.68	9	89	5,431,560	3.33
California	10	84	4,461,661	2.70	10	82	3,599,375	2.21
Michigan	11	92	2,700,066	1.64	11	85	2,770,057	1.70
Kentucky	12	85	2,376,406	1.44	12	78	2,441,290	1.50
Kansas	16	42	1,905,961	1.16	13	43	2,110,877	1.29
Texas	13	102	2,280,987	1.38	14	93	1,976,890	1.21
Georgia	14	76	2,263,034	1.37	15	70	1,845,019	1.13
Minnesota	15	65	1,944,886	1.18	16	66	1,645,913	1.01
Massachusetts	19	57	1,681,557	1.02	17	59	1,583,004	.97
Maryland	17	46	1,846,500	1.12	18	43	1,576,456	.97
Tennessee	21	75	1,546,315	.94	19	69	1,548,220	.95
Connecticut and Rhode Island	24	38	1,229,087	.75	20	38	1,518,773	.93
Washington	18	51	1,809,491	1.10	21	43	1,454,436	.89
Virginia	22	67	1,472,348	.89	22	58	1,447,802	.89
Colorado	25	62	1,143,942	.69	23	58	1,265,105	.78
Alabama	20	70	1,574,023	.95	24	65	1,193,022	.73
North Carolina	23	157	1,460,790	.89	25	137	1,089,935	.67
Oklahoma	28	30	786,314	.48	26	29	996,451	.61
Wisconsin	26	77	950,999	.58	27	75	910,558	.56
Nebraska	30	48	640,955	.39	28	44	776,899	.48
Utah	29	27	676,142	.41	29	29	699,962	.43
Montana	35	21	440,519	.27	30	22	524,575	.32
Maine	27	37	914,908	.55	31	33	488,079	.30
New Hampshire	37	21	398,066	.24	32	19	484,464	.30
Louisiana	36	41	422,062	.26	33	37	385,002	.24
South Carolina	31	38	568,645	.34	34	33	379,133	.23
Mississippi	33	51	530,857	.32	35	48	367,619	.22
Arkansas	34	34	451,986	.27	36	33	343,967	.21
Oregon	32	52	560,271	.34	37	41	341,243	.21
New Mexico	40	9	205,914	.12	38	7	240,847	.15
Florida	39	14	240,094	.15	39	16	203,414	.12
North Dakota	38	11	266,046	.16	40	11	189,355	.12
Delaware	42	15	154,718	.09	41	14	145,694	.09
District of Columbia	43	8	148,866	.09	42	7	131,134	.08
Idaho and Nevada	44	20	110,864	.07	43	22	128,382	.08
Arizona	41	14	156,167	.09	44	11	97,208	.06
Vermont	45	6	75,847	.05	45	5	71,642	.04
Wyoming	46	9	64,942	.04	46	10	57,021	.03
South Dakota	47	7	57,711	.04	47	5	36,342	.02
Porto Rico	48	6	5,974	.00	48	5	4,193	.00
Other States	.....	.....	[a] 669,185	.41	.....	.....	[a] 687,923	.42
		3,860	164,986,983	100.00	.....	3,636	163,120,232	100.00

[a] Undistributed pottery products.

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BRICK AND TILE.

PRODUCTION.

PRODUCTION BY STATES.

The following tables show the output and value of the building brick and other structural products of clay, and of the fire brick, paving brick, and other clay products used in engineering work, the rank of the State in these products, and the percentage of the total value of each State in 1914 and 1915:

Brick and tile products in the United States in 1914.

Rank.	State or Territory.	Common brick.			Vitrified brick or block.		
		Quantity (thousands).	Value.	Average price per thousand.	Quantity (thousands).	Value.	Average price per thousand.
19	Alabama	110,731	$638,666	$5.77	18,679	$248,525	$13.31
41	Arizona	15,994	139,324	8.71			
35	Arkansas	58,921	378,395	6.42	(a)	(a)	12.14
9	California	221,243	1,356,885	6.13	1,800	39,705	22.06
25	Colorado	33,717	211,037	6.26	(a)	(a)	11.52
24	Connecticut and Rhode Island	171,289	1,140,842	6.66	(a)	(a)	16.03
42	Delaware	18,513	147,196	7.95			
43	District of Columbia	13,988	111,883	8.00			
39	Florida	41,901	230,377	5.50	(a)	(a)	12.00
12	Georgia	214,979	1,040,557	4.84	16,470	234,855	14.26
44	Idaho and Nevada	12,638	101,410	8.02			
3	Illinois	941,343	4,896,698	5.20	157,176	2,086,344	13.27
6	Indiana	180,701	1,061,935	5.88	42,937	576,892	13.44
7	Iowa	143,534	1,067,746	7.44	14,997	211,905	14.13
15	Kansas	106,930	486,854	4.55	50,707	594,229	11.72
11	Kentucky	90,124	594,514	6.60	(a)	(a)	12.74
36	Louisiana	63,768	387,517	6.08			
27	Maine	39,961	311,924	7.81			
18	Maryland	146,860	1,180,401	8.04			
21	Massachusetts	139,632	1,023,070	7.33			
10	Michigan	269,154	1,633,216	6.07	7,733	120,562	15.59
14	Minnesota	132,688	883,791	6.67	(a)	(a)	16.12
33	Mississippi	72,978	460,311	6.31			
8	Missouri	169,029	1,157,852	6.85	26,217	424,170	16.18
34	Montana	26,732	270,738	10.13	(a)	(a)	22.50
30	Nebraska	81,691	519,991	6.37	(a)	(a)	11.14
37	New Hampshire	48,216	398,066	8.26			
4	New Jersey	349,434	1,944,806	5.57	(a)	(a)	15.00
40	New Mexico	11,148	94,570	8.48	(a)	(a)	10.40
5	New York	908,868	4,666,087	5.13	31,240	515,672	16.51
23	North Carolina	183,648	1,216,180	6.62			
38	North Dakota	16,857	140,784	8.35			
1	Ohio	436,117	2,862,109	6.56	293,381	3,682,230	12.55
28	Oklahoma	74,391	374,774	5.04	9,912	127,792	12.89
31	Oregon	27,433	210,298	7.67			
2	Pennsylvania	688,178	4,641,269	6.74	151,200	2,052,676	13.58
48	Porto Rico	762	6,970	7.83			
32	South Carolina	89,148	505,839	5.67			
47	South Dakota	6,178	52,404	8.48			
22	Tennessee	137,406	843,363	6.14	(a)	(a)	15.26
13	Texas	182,695	1,180,586	6.46	1,684	23,599	14.01
29	Utah	33,493	270,564	8.08			
45	Vermont	6,990	45,847	6.56			
20	Virginia	187,102	1,229,356	6.57	(a)	(a)	10.00
17	Washington	51,657	351,565	6.81	(a)	(a)	18.99
16	West Virginia	68,022	450,242	6.62	67,750	899,215	13.27
26	Wisconsin	115,056	799,109	6.95			
46	Wyoming	4,733	50,656	10.70			
	Other States[b]				39,441	662,495	16.80
		7,146,571	43,709,524	6.12	931,324	12,500,866	13.42
	Percentage of brick and tile products		33.77			9.65	
	Percentage of total clay products		26.53			7.58	

[a] Included in "Other States." [b] Includes all products made by less than 3 producers in 1 State.

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Brick and tile products in the United States in 1914—Continued.

Rank.	State or Territory.	Front brick. Quantity (thousands).	Front brick. Value.	Front brick. Average price per thousand.	Fancy or ornamental brick (value).	Drain tile (value).	Sewer pipe (value).	Architectural terra cotta (value).	Fireproofing (value).
19	Alabama	(a)	(a)	$11.42	(a)	$6,838	(a)	.....	(a)
41	Arizona	(a)	(a)	25.00	.....	.....	(a)	.....	(a)
35	Arkansas	1,602	$20,288	12.66	.....	(a)	.....	.....	.....
9	California	10,759	226,268	21.03	$21,245	30,284	$959,193	$535,735	$223,071
25	Colorado	10,642	133,068	12.50	(a)	53,971	(a)	(a)	(a)
24	Connecticut and Rhode Island	(a)	(a)	12.24	(a)	.....	.....	.....	(a)
42	Delaware	.....	.....	.....	.....	(a)	.....	.....	.....
43	District of Columbia	.....	.....	.....	.....	(a)	(a)	.....	(a)
39	Florida	.....	.....	.....	.....	(a)	.....	.....	.....
12	Georgia	7,475	77,721	10.40	.....	8,883	647,733	(a)	36,140
44	Idaho and Nevada	(a)	(a)	12.04	.....	.....	.....	.....	(a)
3	Illinois	46,995	506,984	10.79	(a)	1,041,927	743,986	1,652,945	567,266
6	Indiana	80,349	799,520	9.95	.....	1,332,002	586,683	(a)	823,462
7	Iowa	11,183	148,394	13.27	.....	3,180,836	558,751	.....	1,083,397
15	Kansas	31,079	271,104	8.72	(a)	34,130	(a)	(a)	88,427
11	Kentucky	3,828	38,674	10.10	.....	51,645	(a)	.....	33,442
36	Louisiana	(a)	(a)	11.94	.....	.....	.....	.....	(a)
27	Maine	(a)	(a)	8.59	.....	(a)	(a)	.....	.....
18	Maryland	(a)	(a)	16.52	(a)	(a)	.....	(a)	51,483
21	Massachusetts	950	20,000	21.05	.....	.....	.....	.....	(a)
10	Michigan	1,488	21,121	14.19	.....	421,941	(a)	.....	3,752
14	Minnesota	16,413	208,624	12.71	.....	143,194	(a)	.....	123,911
33	Mississippi	.....	.....	.....	.....	49,486	.....	.....	.....
8	Missouri	27,692	411,943	14.88	19,473	143,245	1,236,236	478,006	168,053
34	Montana	754	13,750	18.24	.....	(a)	(a)	.....	(a)
30	Nebraska	2,511	45,326	18.05	.....	1,872	.....	.....	67,586
37	New Hampshire	.....	.....	.....	.....	.....	.....	.....	.....
4	New Jersey	23,640	377,779	15.98	(a)	31,043	(a)	1,620,791	1,599,295
40	New Mexico	(a)	(a)	14.00	.....	.....	.....	.....	(a)
5	New York	5,810	59,039	10.16	(a)	66,217	(a)	889,468	161,725
23	North Carolina	(a)	(a)	11.42	.....	11,850	(a)	.....	(a)
38	North Dakota	5,860	117,356	20.03	.....	.....	.....	.....	(a)
1	Ohio	188,074	1,944,486	10.34	14,727	1,589,565	4,691,719	.....	2,200,544
28	Oklahoma	2,729	25,641	9.40	.....	.....	.....	.....	.....
31	Oregon	2,711	63,659	23.48	(a)	68,115	(a)	.....	38,353
2	Pennsylvania	219,923	2,402,361	10.92	51,068	14,730	940,384	362,348	494,175
48	Porto Rico	.....	.....	.....	.....	.....	.....	.....	.....
32	South Carolina	2,156	28,880	13.40	.....	(a)	.....	.....	(a)
47	South Dakota	(a)	(a)	18.00	.....	(a)	.....	.....	(a)
22	Tennessee	18,594	190,893	10.27	1,469	43,551	(a)	.....	(a)
13	Texas	18,450	249,611	13.53	.....	14,414	(a)	.....	145,830
29	Utah	14,742	189,131	12.83	.....	25,911	(a)	.....	39,921
45	Vermont	.....	.....	.....	.....	.....	.....	.....	.....
20	Virginia	16,831	212,537	12.63	(a)	4,500	(a)	.....	(a)
17	Washington	5,319	109,197	20.53	.....	48,750	462,898	220,788	127,371
16	West Virginia	2,354	37,114	15.77	.....	3,733	(a)	.....	(a)
26	Wisconsin	8,388	78,766	9.39	.....	60,924	.....	.....	(a)
46	Wyoming	1,104	13,838	12.53	.....	.....	.....	.....	.....
	Other States b	19,990	246,550	12.33	16,477	33,482	3,187,184	327,571	308,133
		810,395	9,289,623	11.46	c1,199,485	8,522,039	14,014,767	6,087,652	8,385,337
	Percentage of brick and tile products	.....	7.17	.....	0.93	6.58	10.81	4.70	6.47
	Percentage of total clay products	.....	5.63	.....	.73	5.16	8.49	3.69	5.08

a Included in "Other States."
b Includes all products made by less than 3 producers in 1 State.
c Includes enameled brick valued at $1,075,026 made in the following States: California, Colorado, Illinois, Maryland, Missouri, and New Jersey.

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Brick and tile products in the United States in 1914—Continued.

Rank.	State or Territory.	Tile, not drain (value).	Stove lining (value).	Fire brick.			Miscellaneous [a] (value).	Total value.	Percentage of total value.
				Quantity (thousands).	Value.	Average price per thousand.			
19	Alabama	.....	.....	8,721	$167,021	$19.15	$21,577	$1,557,481	1.20
41	Arizona	.....	.....	(b)	(b)	10.80	.....	156,167	.12
35	Arkansas	.....	.....	(b)	(b)	13.42	.....	432,586	.33
9	California	$214,512	(b)	13,560	358,526	26.44	60,482	4,116,358	3.18
25	Colorado	(b)	.....	10,606	209,368	19.74	113,252	1,082,685	.84
24	Connecticut and Rhode Island	(b)	(b)	(b)	(b)	21.99	.....	1,229,037	.95
42	Delaware	.....	.....	.....	.....	.....	.....	154,718	.12
43	District of Columbia	.....	.....	.....	.....	.....	3,270	148,866	.11
39	Florida	.....	.....	.....	.....	.....	.....	240,094	.18
12	Georgia	(b)	(b)	(b)	(b)	14.95	.....	2,242,073	1.73
44	Idaho and Nevada	.....	.....	(b)	(b)	22.50	.....	110,864	.09
3	Illinois	(b)	(b)	15,416	274,106	17.78	274,359	12,538,374	9.67
6	Indiana	511,433	(b)	3,723	93,900	25.22	426,220	6,503,207	5.02
7	Iowa	(b)	.....	(b)	(b)	19.09	40,146	6,368,995	4.91
15	Kansas	(b)	.....	.....	.....	.....	122,954	1,906,961	1.47
11	Kentucky	270,688	.....	58,780	1,075,158	18.29	11,615	2,286,980	1.76
36	Louisiana	.....	.....	.....	.....	.....	17,596	422,062	.33
27	Maine	.....	.....	(b)	(b)	15.00	924	914,808	.71
18	Maryland	.....	$21,393	12,448	243,043	19.52	.....	1,640,017	1.27
21	Massachusetts	(b)	159,924	2,084	74,736	35.86	.....	1,462,453	1.13
10	Michigan	(b)	(b)	(b)	(b)	19.78	35,000	2,434,872	1.88
14	Minnesota	(b)	.....	(b)	(b)	22.27	.....	1,944,886	1.51
33	Mississippi	.....	.....	.....	.....	.....	6,000	515,797	.40
8	Missouri	(b)	(b)	76,177	1,554,431	20.41	86,845	6,074,340	4.69
34	Montana	.....	.....	1,226	50,517	41.20	.....	440,519	.34
30	Nebraska	.....	.....	.....	.....	.....	.....	640,955	.49
37	New Hampshire	.....	.....	.....	.....	.....	.....	398,066	.31
4	New Jersey	1,139,895	(b)	34,545	897,442	25.98	244,601	8,353,296	6.45
40	New Mexico	.....	.....	(b)	(b)	13.70	.....	205,914	.16
5	New York	(b)	57,837	7,797	321,048	41.18	.....	6,923,141	5.34
23	North Carolina	.....	.....	.....	.....	.....	.....	1,447,994	1.12
38	North Dakota	.....	(b)	(b)	(b)	16.42	.....	266,046	.21
1	Ohio	2,331,079	51,192	102,735	1,833,740	17.85	552,816	21,815,392	16.83
28	Oklahoma	.....	.....	.....	.....	.....	258,107	786,314	.61
31	Oregon	(b)	.....	127	3,830	30.16	82	560,271	.43
2	Pennsylvania	388,887	129,419	298,183	5,774,677	19.37	786,675	20,100,495	15.51
48	Porto Rico	.....	.....	.....	.....	.....	4	5,974	.00
32	South Carolina	.....	.....	1,130	16,850	14.91	.....	557,977	.43
47	South Dakota	.....	.....	.....	.....	.....	.....	57,711	.04
22	Tennessee	.....	.....	1,067	19,717	18.14	.....	1,449,120	1.11
13	Texas	.....	.....	4,860	82,838	17.04	45,008	2,222,240	1.71
29	Utah	.....	(b)	(b)	(b)	33.53	5,113	676,142	.52
45	Vermont	.....	(b)	.....	.....	.....	.....	75,847	.06
20	Virginia	.....	.....	882	11,641	13.20	.....	1,472,348	1.14
17	Washington	.....	.....	1,054	29,869	28.34	27,872	1,809,491	1.40
16	West Virginia	207,778	.....	17,796	146,668	8.24	24,848	1,830,947	1.41
26	Wisconsin	.....	(b)	.....	.....	.....	.....	943,999	.73
46	Wyoming	.....	.....	.....	.....	.....	448	64,942	.05
	Other States [c]	641,311	100,820	14,154	236,896	16.74	.....	(d)	.....
		[e]5,705,583	520,585	[f]816,784	[f]16,427,547	20.11	3,165,814	129,588,822	100.00
	Percentage of brick and tile products	4.40	0.40	.....	12.68	.....	2.44	100.00	.....
	Percentage of total clay products	3.46	.41	.....	9.96	.....	1.92	78.54	.....

[a] Including adobes, assay supplies, burnt-clay ballast, charcoal furnaces, chemical brick, chimney pipe and tops, condensers, conduits, crucibles, flue lining, furnaces for heating irons, gas logs, glass house supplies, grave markers, muffles, radial chimney brick and block, retorts, saggers, scorifiers, segment block, sundials, vases, and wall coping.

[b] Included in "Other States."

[c] Includes all products made by less than 3 producers in 1 State.

[d] The total of "Other States" is distributed among the States to which it belongs in order that they may be fully represented in the totals.

[e] Including the following values: Roofing tile, $1,043,020; floor tile, $881,362; ceramic mosaic tile, $1,520,739; faience tile, $675,615; wall tile, $1,584,847.

[f] In the total quantity and total value of fire brick are included, respectively, 129,693,000 silica brick, valued at $2,951,525, of which 98,336,000, valued at $2,061,826, were produced by Pennsylvania, and the remainder, 31,357,000, valued at $889,699, by Alabama, California, Colorado, Illinois, Indiana, Missouri, Montana, New Jersey, Ohio, and Utah.

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Brick and tile products in the United States in 1915.

Rank.	State or Territory.	Common brick.			Vitrified brick or block.		
		Quantity (thousands).	Value.	Average price per thousand.	Quantity (thousands).	Value.	Average price per thousand.
24	Alabama	70,681	$382,092	$5.41	29,018	$374,387	$12.90
44	Arizona	10,169	85,085	8.36	.....	.....	.....
37	Arkansas	45,001	267,477	5.94	(a)	(a)	12.00
9	California	160,452	981,888	6.12	3,182	66,784	20.99
23	Colorado	35,729	233,089	6.52	(a)	(a)	11.59
17	Connecticut and Rhode Island	211,490	1,382,087	6.53	(a)	(a)	12.66
41	Delaware	17,139	133,733	7.80	.....	.....	.....
42	District of Columbia	14,767	96,150	6.51	.....	.....	.....
39	Florida	31,019	182,149	5.87	.....	.....	.....
14	Georgia	158,465	801,202	5.06	17,193	166,086	9.66
43	Idaho and Nevada	11,933	102,341	8.58	.....	.....	.....
3	Illinois	1,066,057	6,870,990	6.45	142,689	1,796,350	12.59
7	Indiana	137,964	802,224	5.81	35,237	466,873	13.25
6	Iowa	125,752	898,851	7.15	20,573	300,785	14.62
12	Kansas	110,839	499,434	4.51	47,511	608,599	12.81
10	Kentucky	74,807	479,506	6.41	(a)	(a)	10.85
33	Louisiana	62,332	354,023	5.68	.....	.....	.....
31	Maine	35,230	265,777	7.54	(a)	(a)	21.72
22	Maryland	115,814	834,129	7.20	10,439	181,488	17.38
21	Massachusetts	144,520	1,026,179	7.10	.....	.....	.....
11	Michigan	277,399	1,461,188	5.27	4,420	62,238	14.08
16	Minnesota	107,473	675,146	6.28	(a)	(a)	14.18
35	Mississippi	58,705	304,937	5.19	.....	.....	.....
8	Missouri	135,044	898,446	6.65	(a)	(a)	14.62
30	Montana	27,422	277,812	10.13	(a)	(a)	22.01
28	Nebraska	85,753	552,676	6.44	561	8,323	14.84
32	New Hampshire	60,818	434,464	7.97	.....	.....	.....
4	New Jersey	354,104	2,099,654	5.93	.....	.....	.....
38	New Mexico	14,755	108,191	7.33	(a)	(a)	12.00
5	New York	980,580	5,157,677	5.26	24,154	384,458	15.92
25	North Carolina	140,257	862,391	6.15	.....	.....	.....
40	North Dakota	14,620	110,988	7.59	(a)	(a)	11.32
1	Ohio	422,292	2,604,602	6.17	333,288	4,017,758	12.05
26	Oklahoma	64,953	327,208	5.04	16,537	198,387	12.00
36	Oregon	17,723	137,881	7.78	(a)	(a)	9.00
2	Pennsylvania	677,291	4,515,296	6.67	124,354	1,638,518	13.18
48	Porto Rico	507	4,193	8.27	.....	.....	.....
34	South Carolina	60,421	352,389	5.83	.....	.....	.....
47	South Dakota	4,087	33,342	8.16	.....	.....	.....
20	Tennessee	113,004	655,094	5.80	(a)	(a)	14.47
13	Texas	147,469	828,386	5.62	(a)	(a)	15.45
29	Utah	32,785	239,212	7.30	(a)	(a)	29.31
45	Vermont	6,522	41,570	6.37	.....	.....	.....
19	Virginia	186,649	1,215,559	6.51	.....	.....	.....
18	Washington	43,279	285,423	6.59	14,861	265,691	17.88
15	West Virginia	64,649	445,843	6.90	69,474	841,067	12.11
27	Wisconsin	107,268	735,028	6.85	(a)	(a)	20.12
46	Wyoming	5,110	52,290	10.23	.....	.....	.....
	Other States[b]	.....	.....	6.51	59,844	853,107	14.26
		6,851,099	42,145,292	6.15	[c] 963,335	[c] 12,230,899	12.83
	Percentage of brick and tile products	.....	33.50	.....	.....	9.72	.....
	Percentage of total clay products	.....	25.84	.....	.....	7.50	.....

[a] Included in "Other States."
[b] Includes all products made by less than 3 producers in 1 State.
[c] In the total quantity and total value of vitrified brick are included, respectively, 824,359,000 vitrified brick sold for paving, valued at $11,114,427, and 128,976,000 vitrified brick sold for other uses, valued at $1,116,472.

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Brick and tile products in the United States in 1915—Continued.

Rank.	State or Territory.	Front brick.			Fancy or ornamental brick, value.	Drain-tile, value.	Sewer pipe, value.	Architectural terra cotta, value.	Fireproofing value.
		Quantity (thousands).	Value.	Average price per thousand.					
24	Alabama	5,815	$58,212	$10.01	.....	$9,330	(a)	.....	$62,114
44	Arizona	(a)	(a)	19.87	.....	.....	.....	.....	.....
37	Arkansas	1,973	32,572	16.51	.....	3,969	.....	.....	.....
9	California	10,348	221,791	21.43	(a)	33,222	$707,480	$308,930	174,739
23	Colorado	9,538	102,925	10.79	$17,699	49,125	(a)	(a)	22,560
17	Connecticut and Rhode Island	(a)	(a)	36.17	(a)	.....	.....	.....	(a)
41	Delaware	.....	.....	.....	.....	(a)	.....	.....	.....
42	District of Columbia	.....	.....	.....	.....	(a)	(a)	.....	(a)
39	Florida	.....	.....	.....	.....	(a)	.....	.....	(a)
14	Georgia	8,483	78,826	9.29	.....	(a)	567,118	(a)	(a)
43	Idaho and Nevada	(a)	(a)	15.00	.....	.....	.....	.....	(a)
3	Illinois	58,107	635,686	10.94	(a)	991,709	569,536	1,289,848	492,138
7	Indiana	83,610	897,242	10.73	(a)	1,253,805	563,144	(a)	651,714
6	Iowa	11,916	153,324	12.87	.....	3,802,599	448,721	.....	1,008,457
12	Kansas	31,429	292,584	9.31	.....	63,813	(a)	(a)	125,234
10	Kentucky	3,252	33,062	10.17	.....	64,948	(a)	.....	32,311
33	Louisiana	(a)	(a)	10.73	.....	.....	.....	.....	.....
31	Maine	(a)	(a)	8.00	.....	(a)	(a)	.....	.....
22	Maryland	(a)	(a)	11.39	(a)	2,271	.....	(a)	(a)
21	Massachusetts	(a)	(a)	20.00	.....	.....	.....	.....	(a)
11	Michigan	3,619	40,822	11.28	.....	305,156	(a)	.....	10,850
16	Minnesota	17,157	205,519	11.98	.....	255,347	(a)	.....	125,595
35	Mississippi	618	6,715	10.87	.....	36,077	.....	.....	.....
8	Missouri	26,040	335,767	12.89	16,360	152,445	1,012,337	259,662	134,690
30	Montana	837	15,496	18.51	.....	(a)	(a)	.....	(a)
28	Nebraska	7,582	116,650	15.39	(a)	9,599	.....	.....	79,973
32	New Hampshire	.....	.....	.....	.....	.....	.....	.....	.....
4	New Jersey	25,698	375,431	14.61	(a)	41,331	(a)	1,430,968	1,389,120
38	New Mexico	5,052	81,621	16.16	.....	.....	.....	.....	30,212
5	New York	6,272	70,142	11.18	(a)	61,593	(a)	647,816	148,946
25	North Carolina	(a)	(a)	10.00	.....	14,600	(a)	.....	(a)
40	North Dakota	(a)	(a)	15.37	(a)	.....	.....	.....	(a)
1	Ohio	185,605	1,925,096	10.37	20,844	1,430,385	3,719,790	.....	2,172,701
26	Oklahoma	16,899	166,454	9.85	.....	.....	.....	.....	.....
36	Oregon	2,821	58,215	20.64	.....	46,328	(a)	.....	40,228
2	Pennsylvania	244,781	2,631,795	10.75	17,327	12,200	1,003,913	(a)	486,164
48	Porto Rico	.....	.....	.....	.....	.....	.....	.....	.....
34	South Carolina	(a)	(a)	14.50	.....	(a)	.....	.....	.....
47	South Dakota	(a)	(a)	15.00	.....	.....	.....	.....	.....
20	Tennessee	17,190	139,697	8.13	(a)	47,914	(a)	.....	(a)
13	Texas	18,413	225,034	12.22	.....	10,846	(a)	.....	152,832
29	Utah	12,489	126,585	10.14	.....	22,417	(a)	.....	27,792
45	Vermont	.....	.....	.....	.....	(a)	.....	.....	.....
19	Virginia	15,705	192,443	12.25	(a)	7,450	(a)	.....	(a)
18	Washington	4,246	67,740	15.95	.....	33,558	318,397	234,377	192,263
15	West Virginia	1,271	15,606	12.28	.....	6,189	(a)	.....	(a)
27	Wisconsin	8,624	95,224	11.04	.....	67,766	.....	.....	(a)
46	Wyoming	271	4,368	16.12	.....	.....	.....	.....	.....
	Other States b	10,004	132,892	13.28	37,195	43,272	2,348,913	624,461	240,310
		855,668	9,535,536	11.14	c945,233	8,879,264	11,259,349	4,796,062	7,800,988
	Percentage of brick and tile products	.....	7.58	.....	.75	7.06	8.95	3.81	6.20
	Percentage of total clay products	.....	5.85	.....	.58	5.44	6.90	2.94	4.78

a Included in "Other States."
b Includes all products made by less than 3 producers in 1 State.
c Includes enameled brick, valued at $835,808, made in the following States: California, Colorado, Illinois, Maryland, Missouri, Nebraska, and New Jersey.

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Brick and tile products in the United States in 1915—Continued.

Rank.	State or Territory.	Tile, not drain, value.	Stove lining, value.	Fire brick. Quantity (thousands).	Fire brick. Value.	Fire brick. Average price per thousand.	Miscellaneous,[a] value.	Total value.	Percentage of total value.
24	Alabama	.....	(b)	7,330	$145,535	$19.85	$4,913	$1,177,725	0.94
44	Arizona	.....	.....	.....	.....	.....	.....	97,208	.08
37	Arkansas	.....	.....	(b)	(b)	13.05	.....	323,682	.26
9	California	$164,524	(b)	16,821	421,505	25.06	83,089	3,231,281	2.57
23	Colorado	9,624	.....	10,031	256,059	25.53	149,727	1,202,220	.96
17	Connecticut and Rhode Island	(b)	(b)	(b)	(b)	22.00	.....	1,518,773	1.21
41	Delaware	.....	.....	.....	.....	.....	.....	145,694	.12
42	District of Columbia	.....	.....	.....	.....	.....	.....	131,134	.10
39	Florida	.....	.....	.....	.....	.....	.....	203,414	.16
14	Georgia	.....	.....	3,733	54,000	14.47	7,542	1,826,842	1.45
43	Idaho and Nevada	.....	.....	(b)	(b)	22.50	.....	128,382	.10
3	Illinois	(b)	(b)	18,704	320,740	17.15	329,549	13,843,046	11.00
7	Indiana	(b)	.....	5,378	107,539	20.00	346,834	5,892,596	4.68
6	Iowa	(b)	(b)	(b)	(b)	24.42	41,145	6,738,190	5.36
12	Kansas	(b)	.....	.....	.....	.....	240,104	2,110,877	1.68
10	Kentucky	205,184	.....	77,170	1,325,804	17.18	17,932	2,332,451	1.85
33	Louisiana	.....	.....	.....	.....	.....	18,172	385,002	.31
31	Maine	.....	.....	(b)	(b)	31.08	1,992	488,079	.39
22	Maryland	.....	$18,677	11,808	226,090	19.15	(b)	1,369,738	1.09
21	Massachusetts	95,929	161,795	1,690	60,735	35.94	2,350	1,399,371	1.11
11	Michigan	(b)	.....	(b)	(b)	8.00	49,755	2,248,068	1.79
16	Minnesota	.....	.....	(b)	(b)	40.00	.....	1,645,913	1.31
35	Mississippi	.....	.....	.....	.....	.....	4,200	351,929	.28
8	Missouri	(b)	(b)	99,945	1,922,738	19.24	82,877	5,428,403	4.31
30	Montana	.....	.....	837	34,992	41.81	41,799	524,575	.42
28	Nebraska	.....	.....	.....	.....	.....	1,348	776,899	.62
32	New Hampshire	.....	.....	.....	.....	.....	.....	484,464	.38
4	New Jersey	995,097	(b)	36,403	899,613	24.71	264,299	7,916,080	6.29
38	New Mexico	.....	.....	(b)	(b)	15.20	.....	240,847	.19
5	New York	75,685	65,064	8,614	340,151	39.49	40,040	7,047,262	5.60
25	North Carolina	.....	.....	(b)	(b)	15.00	.....	1,078,541	.86
40	North Dakota	.....	.....	(b)	(b)	25.62	.....	189,355	.15
1	Ohio	2,334,375	(b)	123,179	1,996,792	16.21	548,108	20,909,842	16.62
26	Oklahoma	.....	.....	236	21,540	91.27	282,362	996,451	.79
36	Oregon	(b)	.....	60	2,030	33.83	.....	341,243	.27
2	Pennsylvania	299,907	104,995	379,042	7,177,629	18.94	793,405	20,898,282	16.61
48	Porto Rico	.....	.....	.....	.....	.....	.....	4,193	.00
34	South Carolina	.....	.....	(b)	(b)	15.00	.....	370,152	.29
47	South Dakota	.....	.....	.....	.....	.....	.....	36,342	.03
20	Tennessee	.....	.....	(b)	(b)	13.50	140,515	1,441,831	1.15
13	Texas	.....	.....	5,054	83,236	16.47	91,919	1,911,501	1.52
29	Utah	.....	(b)	(b)	(b)	31.90	5,715	699,962	.56
45	Vermont	.....	(b)	.....	.....	.....	.....	71,642	.06
19	Virginia	.....	.....	(b)	(b)	13.93	.....	1,447,802	1.15
18	Washington	.....	.....	1,569	45,414	28.94	11,573	1,454,436	1.16
15	West Virginia	181,495	.....	16,807	143,301	8.53	106,579	1,773,904	1.41
27	Wisconsin	.....	(b)	.....	.....	.....	.....	902,199	.72
46	Wyoming	.....	.....	(b)	(b)	18.00	345	57,021	.04
	Other States[c]	824,235	108,810	9,328	214,619	23.01	8,256	(d)	.....
		[e]5,186,055	459,341	[f]963,983	[f]18,839,931	19.54	3,716,944	125,794,844	100.00
	Percentage of brick and tile products	4.12	.37	.....	14.98	.....	2.96	100.00	.....
	Percentage of total clay products	3.18	.28	.....	11.55	.....	2.28	77.12	.....

[a] Including adobes, assay supplies, burnt-clay ballast, charcoal furnaces, chemical brick and tile, chimney flues, pipe thimbles and tops, condensers, conduits, crucibles, flue lining, gas logs, glasshouse supplies, grave and lot markers, muffles, sewer and chimney radial brick and block, retorts, scorifiers, sewer brick and blocks, sundials, vases, and will coping.

[b] Included in "Other States."

[c] Includes all products made by less than 3 producers in 1 State.

[d] The total of "Other States" is distributed among the States to which it belongs, in order that they may be fully represented in the totals.

[e] Includes the following values: Roofing tile, $891,150; floor tile, $912,180; ceramic mosaic tile, $1,185,787; faïence tile, $635,073; wall tile, $1,561,865.

[f] In the total quantity and total value of fire brick are included, respectively, 130,244,000 silica brick, valued at $3,039,869, of which 92,348,000, valued at $1,911,321, were produced by Pennsylvania; and the remainder, 37,896,000, valued at $1,128,548, by Alabama, Colorado, Illinois, Indiana, Missouri, Montana, New Jersey, Ohio, and Utah.

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Common brick, as its name implies, is the most widely distributed of the clay products, being reported for 1915 from every State and Territory except Alaska and Hawaii. There was a decrease of 295,472,000 brick, or 4 per cent, compared with 1914. In 1914 there was a decrease of 942,219,000 brick. Twelve States reported an increased quantity and value of common brick marketed in 1915 compared with 1914, namely, Colorado, Connecticut, and Rhode Island (taken together), Illinois, Kansas, Massachusetts, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, and Wyoming. The District of Columbia and Michigan reported increase in quantity of common brick marketed, but decrease in value. Idaho and Nevada (taken together) decreased in quantity of product marketed, but increased in value.

Illinois was the largest producer of common brick in 1915, as for several years, followed by New York, Pennsylvania, Ohio, and New Jersey in the order named. Of the output of Illinois, 739,173,000 brick, or 69 per cent, was from Cook County, and of the output of New York, 741,568,000 brick, or three-fourths, was from the Hudson River region. In 13 States the average price per thousand brick in 1915 was equal to, or greater than, that for 1914; in 35 States it decreased. The average price per thousand ranged from $4.51 in Kansas to $10.23 in Wyoming; in 1914 the same States reported the extremes in average price of $4.55 and $10.70. In Illinois the average price per thousand increased $1.25 to $6.45; in New York it increased 13 cents to $5.26; in Pennsylvania it decreased 7 cents to $6.67; in Ohio it decreased 39 cents to $6.17; and in New Jersey it increased 36 cents to $5.93.

Vitrified brick or block, the third brick and tile product in value in 1915, was reported from 31 States, an increase of three. Maine, Maryland, North Dakota, Oregon, Utah, and Wisconsin, which reported none for 1914, reentered the list of producers, and Florida, New Jersey, and Virginia dropped out. Ohio, as for many years, was the leading State, reporting 35 per cent of the total quantity and 33 per cent of the total value in 1915. Illinois ranked second, reporting 15 per cent of the quantity and value; Pennsylvania third, with 13 per cent of the quantity and value; West Virginia fourth, with 7 per cent; and Kansas fifth, with 5 per cent. These five States, therefore, reported for 1915 nearly three-fourths of the entire output. Of the output marketed in 1915, 824,359,000 brick or block, or 86 per cent, was sold for paving and 128,976,000, or 14 per cent, was sold for other purposes. The average price per 1,000 of the vitrified brick sold for paving was $13.48; for other purposes, $8.66. The quantity of vitrified brick or block marketed in 1914 was 953,335,000, an increase of 22,011,000 brick or block over 1914, but owing to lower prices the total value decreased. The average price per thousand for vitrified brick or block ranged in the more important producing States from $10.85 in Kentucky to $22.01 in Montana.

Next to the common brick industry, that of front or face brick—the fifth in value among the brick and tile products—is most widely distributed, sales being reported from 42 States in 1915, an increase of 1, Mississippi. Pennsylvania, as for many years, was the leading front-brick producing State in 1915, with 29 per cent of the quantity and 28 per cent of the value of the marketed production. Ohio ranked second, Indiana third, and Illinois fourth. Kansas was fifth

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in quantity and seventh in value. Missouri was sixth in quantity and value, and New Jersey seventh in quantity and fifth in value. The average price per thousand ranged from $8 in Maine to $21.43 in California. There was an increase in the quantity of front brick reported in 1915 of 45,273,000 compared with 1914.

Draintile, the sixth brick and tile product in 1915 in value, was reported from 36 States in 1915, the same number as in 1914, though South Dakota reported none for 1915, and Vermont entered the list of draintile makers. Iowa, Ohio, Indiana, Illinois, and Michigan were the leading States in the order named. These five States together reported draintile valued at $7,783,654, or 88 per cent of the total. This was an increase of $217,383, or 3 per cent, over 1914. Iowa was the only one of these leading States that showed an increase in value of output over 1914.

Sewer pipe was reported from 27 States in 1915, a decrease of 1, Arizona. Ohio, as for many years, was the leading State, reporting nearly one-third of the entire output. Missouri ranked second, as in 1914, with Pennsylvania a close third, California fourth, and Illinois fifth. Pennsylvania was the only one of the important sewer pipe producing States that reported an increase in 1915. In 1914 California was third by a small margin and Pennsylvania fourth. These five States reported 62 per cent of the total in 1915. Sewer pipe ranked fourth in value among the brick and tile products in 1915 and third in 1914.

Architectural terra cotta was reported from 12 States in 1915, the same as in 1914. In only 6 States were there a sufficient number of producers to permit the publication of figures without disclosing confidential information. New Jersey was the leading State in 1915, regaining this position which it had held for many years until in 1914, when Illinois was first. Illinois ranked second in 1915, and New York third. These three States reported 70 per cent of the total for 1915.

Fireproofing, including hollow building tile or block, was reported from 35 States in 1915, a decrease of 3 from 1914 Arizona, Louisiana, South Carolina, and South Dakota dropping out, and Florida entering the list of producers. Ohio was the leading State in 1915, as in 1914, and reported 28 per cent of the total. New Jersey ranked second, and Iowa third. These three States reported 59 per cent of the total in 1915. Fireproofing ranked seventh in value among the brick and tile products in 1915.

Tile, not drain, includes roofing, floor, wall, mosaic, ceramics, and faïence tile. These products were reported from 17 States in 1915, a decrease of 2, Georgia and Minnesota. Ohio continued to be the leading State in 1915, reporting 45 per cent of the total. New Jersey ranked second. These two States reported nearly two-thirds of the total for 1915.

Fire brick ranks second in value among the brick and tile products. It was reported from 35 States in 1915, an increase of 2. North Carolina, Oklahoma, and Wyoming, which reported none for 1914, reported fire brick for 1915, and Arizona, which reported this product for 1914, reported none for 1915. The quantity of 9-inch equivalent brick reported, including silica brick, increased 147,199,000 brick, or 18 per cent, and the value increased $2,412,384, or 15 per cent. The average price per thousand in 1915 for all fire brick was $19.54, a

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decrease of 57 cents. The total number of clay 9-inch equivalent fire brick was 833,739,000, valued at $15,800,062, or $18.95 per thousand, an increase of 146,648,000 brick, or 21 per cent in quantity, and of $2,324,040, or 17 per cent, in value. Pennsylvania continued to be the leading producer of both clay and silica fire brick, reporting 45 per cent of the quantity and value of clay fire brick and 71 per cent of the quantity and 63 per cent of the value of silica fire brick in 1915. If clay and silica fire brick be considered together, Pennsylvania produced nearly one-half—49 per cent of the quantity and 48 per cent of the value—of the total output reported for 1915. Ohio was second in quantity and value of fire brick, Missouri was third, Kentucky fourth, and New Jersey fifth in 1915, as in 1914. These five States reported 86 per cent of the quantity and 84 per cent of the value of clay fire brick in 1915.

The production of silica fire brick in 1915 was 130,244,000 9-inch equivalent brick valued at $3,039,869, or $23.34 per thousand, an increase of 551,000 brick and of $88,344.

Ohio ranked first in the value of brick and tile products, leading Pennsylvania by the small margin of $11,560. There was a decrease in the value of Ohio's brick and tile products of $905,550, or 4 per cent, in 1915, compared with 1914. Pennsylvania was for many years the leading State in brick and tile products, but in 1914, owing to the large decrease in these products in Pennsylvania ($2,084,888), Ohio took first rank. In 1915, however, there was an increase of $797,787, or 4 per cent, in the value of Pennsylvania's brick and tile products. Illinois was third, as in 1914, with an increase of $1,304,672, New Jersey was fourth with a decrease of $437,216, and New York was fifth, with an increase of $124,121. Iowa was sixth, displacing Indiana; Missouri was eighth, and California ninth, as in 1914, and Kentucky was tenth, exchanging places with Michigan, which was eleventh.

TILE, NOT DRAIN.

Under the head "Tile, not drain," are embraced the varieties of higher grades of tile used almost exclusively in structural work. There are numerous subdivisions and trade names for these varieties, but owing to the small number of producers of some of them, it has been thought best to classify them as roofing, floor, ceramic, mosaic, faïence, and wall tile.

Tile, not drain, of domestic production sold in the United States in 1913, 1914, and 1915.

Variety.	1913		1914		1915	
	Value.	Number of firms reporting sales.	Value.	Number of firms reporting sales.	Value.	Number of firms reporting sales.
Roofing	$1,130,286	24	$1,043,020	26	$891,150	23
Floor	2,483,082	39	881,362	41	912,180	44
Ceramic mosaic	(a)	.....	1,520,739	18	1,185,787	19
Faïence	731,820	23	675,615	23	635,073	23
Wall	1,763,992	15	1,584,847	19	1,561,865	19
	6,109,180	.....	5,705,583	.....	5,186,055	.....

[a] Not separately classified.

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Floor tile, including ceramic mosaics, continues to be the tile of greatest value and represented over 40 per cent of the total in 1915. There was a decrease of $304,134, or 13 per cent, in the value of these varieties of tile marketed in 1915 compared with 1914. This decrease was in the ceramic mosaics, the floor tile showing an increase. Floor tile was reported from California, Colorado, Illinois, Indiana, Kentucky, Massachusetts, New Jersey, New York, Ohio, Oregon, Pennsylvania, Rhode Island, and West Virginia. Ohio was the leading State, with sales valued at $293,556, New Jersey was second, and Indiana third. Ceramic mosaics were reported from Indiana, Kentucky, Massachusetts, New Jersey, New York, Ohio, Pennsylvania, and West Virginia. Ohio was also the leading State in the production of this variety of tile, its marketed output in 1915 being valued at $561,286, or 47 per cent of the total, and New Jersey was second, with marketed production valued at $253,365, or 21 per cent of the total. These two States, therefore, reported more than two-thirds of the total for this variety.

Wall tile, constituting 30 per cent of all tile, not drain, in 1915, was reported from California, Indiana, Kentucky, Missouri, New Jersey, Ohio, and Pennsylvania. There was a small decrease in value ($22,982) in 1915 compared with 1914. Ohio was the leading producer and reported an output valued at $732,789, or 47 per cent of the total, an increase of $85,854, or 13 per cent. This output was reported entirely from Muskingum County. New Jersey was second, with an output valued at $398,258, or 25 per cent of the total, a decrease of $40,932.

Roofing tile was reported in 1915 from California, Colorado, Iowa, Kansas, Kentucky, Michigan, Missouri, Ohio, Oregon, Pennsylvania, and West Virginia. There was a decrease of $151,870, or nearly 15 per cent in value. Ohio was the leading State, reporting roofing tile marketed to the value of $416,100, or nearly one-half of the entire output. This was a decrease of $31,333, or 7 per cent, from 1914. California ranked second, and Kansas third, as in 1914.

Faïence tile was reported from California, Colorado, Indiana, Kentucky, Massachusetts, Michigan, New Jersey, Ohio, Pennsylvania, and West Virginia in 1915, and showed a decrease of $40,542, or 6 per cent. Ohio was the leading State, reporting faïence tile marketed to the value of $330,644, or more than half of the entire output.

HUDSON RIVER REGION.

Greater New York is the leading common-brick market in the United States, about a billion brick being used there annually. The principal source of this supply is the Hudson River region, extending from New York to Cohoes, on both sides of the river. Bergen County, N. J., has contributed largely to this market, and within the last few years the Raritan River region, in Middlesex County, N. J., has also sent the larger portion of its output of common brick to the New York market. For this reason it is included in the table showing the output of the Hudson River region. Connecticut also is at times a contributor to the New York City brick market. The water transportation enjoyed by the Hudson River yards and those located in the Hackensack and Raritan districts, however, gives them a great advantage, and it is only when the prices are high—above $7 a thousand—that Connecticut brick can profitably enter the New

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York City market. As prices were low in 1915, few, if any, Connecticut brick were shipped to New York City during that year.

The year 1915 was notable in this region principally for the revival of business and an increase in marketed production and value over 1914; also for an increase in the average price per thousand received for brick.

Common brick produced and sold in the Hudson River district, 1901 to 1915.

Year.	Number of firms reporting sales.	Quantity (thousands).	Value.	Average price per thousand.
1901	127	830,154	$3,880,215	$4.67
1902	127	833,065	3,683,379	4.42
1903	115	844,500	3,973,316	4.70
1904	119	987,644	5,810,114	5.88
1905	129	1,297,389	9,063,753	6.99
1906	135	1,274,372	7,672,639	6.02
1907	132	1,064,892	5,515,585	5.18
1908	123	875,979	4,107,382	4.69
1909	127	1,313,760	6,438,642	4.90
1910	135	1,142,284	5,544,600	4.85
1911	125	926,072	4,717,633	5.09
1912 [a]	136	1,233,187	7,133,177	5.78
1913 [a]	132	1,025,308	5,636,061	5.50
1914 [a]	129	888,266	4,350,832	4.90
1915 [a]	120	960,527	5,009,065	5.21

[a] Includes Raritan district, New Jersey.

The number of brick marketed in this region in 1915 increased 72,261,000, or 8 per cent, and the value increased $658,233, or 15 per cent. The average price per thousand brick for the region increased 31 cents, compared with 1914, but was below the average of the three preceding years. The number of operators reporting sales in 1915 was the smallest since 1904.

In the New York and Bergen County, N. J., portions of the region the marketed production was 776,867,000 brick, valued at $3,942,394, a considerable increase. The average price per thousand for this portion of the region was 20 cents higher than in 1914. The number of operators (111) reporting sales in 1915 decreased 7, as compared with 1914.

Common brick produced and sold in the Hudson River district (from Cohoes to New York City and in Raritan district, N. J., in 1914 and 1915.

County.	1914				1915			
	Number of firms reporting sales.	Common brick.			Number of firms reporting sales.	Common brick.		
		Quantity (thousands).	Value.	Average price per thousand.		Quantity (thousands).	Value.	Average price per thousand.
Albany	13	62,107	$335,152	$5.40	12	65,712	$385,945	$5.87
Columbia	6	42,511	204,104	4.80	5	56,003	266,515	4.76
Dutchess	17	81,455	378,877	4.65	15	117,711	592,278	5.03
Green	6	23,979	107,400	4.48	6	28,289	137,083	4.85
Orange	9	91,000	383,500	4.21	8	91,889	447,273	4.87
Rensselaer	5	10,194	64,963	6.37	4	9,111	52,646	5.78
Rockland	23	131,076	642,267	4.90	23	95,890	507,414	5.29
Ulster	24	186,381	896,306	4.81	22	229,343	1,110,492	4.84
Westchester	6	50,417	270,830	5.37	6	47,630	244,902	5.14
Total for New York portion of district	109	679,120	3,283,399	4.83	101	741,568	3,744,548	5.05
Bergen County, N. J.	9	44,806	241,908	5.40	10	35,299	197,846	5.60
Raritan district (Middlesex County), N. J.	11	164,340	825,525	5.02	9	183,660	1,066,671	5.81
Grand total	129	888,266	4,350,832	4.90	120	960,527	5,009,065	5.21

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New York's portion of the region is by far the larger producer, reporting for 1915 over 77 per cent of the quantity and nearly 75 per cent of the value of the entire region. The increase in the quantity of brick sold in this portion of the region in 1915 was 62,448,000 brick, or 9 per cent, and in value of the sales it was $461,149, or 14 per cent.

Of the counties included in the New York portion, Ulster, as for many years, was first in output and value, reporting nearly 31 per cent of the quantity and 30 per cent of the value of brick marketed in 1915, an increase of 42,962,000 brick, or 23 per cent, in quantity and of $214,186, or 24 per cent, in value over 1914. Dutchess County was second, displacing Rockland County which was third. The marketed production from Dutchess County increased 36,256,000 brick, or 45 per cent, and the value of this output increased $213,401, or 56 per cent. In Rockland County the decrease was 35,196,000 brick, or 27 per cent, in quantity and $134,853, or 21 per cent, in value. Of the nine counties in New York six showed increase in both quantity and value. The greatest increase was in Ulster County and the greatest decrease was in Rockland County. Rockland was the only important county to show decrease. The average price per 1,000 increased in every county but three—Columbia, Rensselaer, and Westchester. The greatest increase in average price per 1,000 was 66 cents, in Orange County.

New Jersey's portion of the production of this region was comparatively small—218,959,000 brick, valued at $1,264,517—but owing to the higher prices received in 1915 its proportionate value was somewhat larger, the proportions being 23 per cent of the quantity and 25 per cent of the value. Bergen County's output and value decreased in 1915, but in the Raritan district both marketed production and value increased considerably—19,320,000 brick, or 12 per cent, in quantity and $241,146, or 29 per cent, in value, net increase being 9,813,000 brick and $197,084. The average price per thousand brick in the New Jersey portion of the region was $5.78 in 1915 and $5.10 in 1914.

The number of operators reporting sales decreased 9, of whom 8 were in the New York portion of the region.

POTTERY.

GENERAL STATEMENT.

A study of the following tables shows that the pottery industry has made much progress, that the value of the domestic output has nearly doubled in the last 15 years, that from an industry of minor importance, both as to quality and value, pottery has risen to great importance, supplying large quantities of wares of ever-increasing excellence, and that this country has reached a state where it is practically independent of the Old World in manufacture of pottery, more than four-fifths of the wares now sold being domestic. The imports of pottery, which have always been a large factor in consumption, reached their maximum value in 1907 and have declined since that date, the acceleration of the decline in the last two years being doubtless due to the European war. In 1915 they were valued at less than half as much as in 1907.

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The exports of pottery have never been very great, especially of wares of the highest grade, but the latter have been increasing and in 1915 showed their maximum value. Canada is the principal consumer of exported pottery, though the Republics to the south of us offer attractive fields for expansion, and exports to them increased in 1915.

The value of all domestic pottery marketed in 1915 was $37,325,388, an increase of $1,927,227, or more than 5 per cent, over 1914. This value was the largest on record except that for 1913, which exceeded it by about 2 per cent. The pottery imports decreased $1,770,507, or 21 per cent, and the ratio of production to consumption was the highest recorded. Every product, as classified in this report, except one—china—increased in value in 1915, compared with 1914. White ware, the product of largest value and the one of most general interest, reached its maximum value in 1915, as did also the commonest of pottery products, red earthenware.

The increase in production came during the latter part of the year. In the early months, unlike those of 1914, business was reported as somewhat slack, but the fall trade was brisk, and the year closed with orders plentiful. The normal rate of increase of pottery consumption in this country has not been maintained during the last few years, but with the return of prosperity, as shown by the improvement of trade during the later part of 1915, there is every prospect that the pottery output in 1916 will be greater than heretofore.

One of the effects of the European war has been to create a scarcity of dolls of all kinds, and especially of china dolls and doll heads. Up to 1915 no porcelain dolls or doll heads had been made on a commercial scale in the United States. Efforts are now being made, with fair prospect of success, to establish this industry in this country. Another result of the war has been to stimulate the American potter so to improve his wares that he may hold, after the European war is over, the trade, both foreign and domestic, gained as a result of the decreased shipments of foreign wares; for it is believed that the European potters, on account of the loss of men, will not be able for some time to produce the volume of ware formerly turned out, and presumably also the cost of production of European wares will be greater than heretofore.

PRODUCTION.

Production of porcelain electrical supplies, in which there was the largest decrease in 1914, showed the largest increase in 1915—$540,932, or more than 13 per cent. White ware and stoneware also increased considerably in value. The value of china showed a small decrease—$54,530, or about 2 per cent.

The value of white ware, including china, but excluding sanitary ware and porcelain electrical supplies, was $17,654,398 in 1915, an increase of $301,633 over 1914. If the value of sanitary ware and porcelain electrical supplies be added, the total for 1915 would be $30,318,816, or more than 81 per cent of the value of all pottery products, and an increase of $961,512.

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Value of pottery products in the United States, 1898–1915.

Year.	Number of firms reporting sales.	Red earthenware.	Stoneware and yellow and Rockingham ware.	White ware, including C. C. ware, etc.	China, bone china, delft, and belleek ware.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.	Total.
1898	453	$641,846	$2,408,657	$7,461,635	$942,753	$1,714,351	$451,677	$968,305	$14,589,224
1899	619	775,105	2,527,404	7,914,776	1,319,333	2,164,885	470,355	2,078,392	17,250,250
1900	561	832,447	[a]2,662,616	10,323,963	1,292,589	2,217,052	915,433	[a]1,554,470	19,798,570
1901	535	703,698	2,855,638	11,608,898	1,392,864	2,877,650	1,141,362	1,883,750	22,463,860
1902	518	735,386	3,383,678	12,371,111	1,219,293	3,555,662	1,350,255	1,512,068	24,127,453
1903	546	698,175	3,658,836	12,493,012	1,757,502	3,362,263	1,464,980	2,001,284	25,436,052
1904	556	756,625	3,701,844	11,924,404	1,512,115	3,585,375	1,431,452	2,246,455	25,158,270
1905	533	780,637	3,969,016	12,809,414	1,558,730	4,580,145	2,253,061	1,967,891	27,918,894
1906	540	909,262	4,193,884	14,152,503	1,787,776	5,098,310	2,838,284	2,460,865	31,440,884
1907	509	845,465	4,280,601	13,913,680	1,930,669	4,863,222	2,613,771	1,696,066	30,143,474
1908	497	757,900	3,518,841	11,474,147	1,581,020	4,373,590	2,009,005	1,421,052	25,135,555
1909	466	805,906	3,993,859	13,728,316	[b]1,766,766	5,989,295	3,047,499	[b]1,717,800	31,049,441
1910	463	854,196	3,796,688	14,780,980	1,962,126	6,758,996	3,794,153	1,837,539	33,784,678
1911	449	893,678	4,120,608	14,366,251	2,057,985	7,031,458	4,232,101	1,816,479	34,518,560
1912	434	958,270	3,919,778	14,829,431	2,177,305	7,902,255	4,927,316	1,789,809	36,504,164
1913	426	1,000,529	3,683,567	15,066,811	2,424,060	8,214,838	5,737,741	1,864,829	37,992,375
1914	412	1,059,904	3,349,301	14,968,079	2,384,686	7,874,269	4,130,270	1,631,652	35,398,161
1915	416	1,072,061	3,575,603	15,324,242	2,330,156	7,993,216	4,671,202	2,358,908	37,325,388

[a] Yellow or Rockingham ware (decorated) for Ohio is included in miscellaneous.
[b] China, bone china, delft, and belleek ware for Ohio is included in miscellaneous.

Value of pottery products in 1914.

Rank of State.	State.	Number of firms reporting sales.	Red earthenware.	Stoneware and yellow and Rockingham ware.	White ware including C. C. ware, white granite, semiporcelain ware, and semivitreous porcelain ware.	China, bone china, delft, and belleek ware.
19	Alabama	13	$4,800	$11,742	.....	.....
18	Arkansas	3	[a]	13,135	.....	.....
8	California	12	36,931	[a]	.....	.....
14	Colorado	5	[a]	[a]	.....	.....
	Connecticut	.....	[a]	[a]	.....	.....
	District of Columbia	.....	[a]	.....	.....	.....
17	Georgia	17	16,487	4,474	.....	.....
7	Illinois	22	37,452	483,407	[a]	.....
6	Indiana	11	[a]	39,000	[a]	.....
16	Iowa	3	[a]	[a]	.....	.....
	Kansas	.....	.....	[a]	.....	.....
13	Kentucky	7	35,731	53,695	.....	.....
	Louisiana	.....	[a]	.....	.....	.....
	Maine	.....	.....	[a]	.....	.....
11	Maryland	6	7,738	[a]	[a]	.....
10	Massachusetts	8	[a]	[a]	.....	.....
9	Michigan	5	106,452	.....	.....	.....
	Minnesota	.....	[a]	[a]	.....	.....
20	Mississippi	7	[a]	14,510	.....	.....
24	Missouri	5	2,243	[a]	.....	.....
	Montana	.....	[a]	.....	.....	.....
	Nebraska	.....	[a]	.....	.....	.....
2	New Jersey	52	35,198	72,288	$727,637	$1,076,043
4	New York	21	36,251	[a]	[a]	784,604
21	North Carolina	21	1,477	11,078	.....	.....
1	Ohio	103	300,453	1,592,102	10,227,806	.....
	Oregon	.....	[a]	[a]	.....	.....
5	Pennsylvania	23	194,581	282,511	[a]	[a]
22	South Carolina	5	8,843	[a]	.....	.....
12	Tennessee	9	4,437	27,227	.....	.....
15	Texas	14	12,724	44,230	.....	.....
	Utah	.....	[a]	.....	.....	.....
	Washington	.....	[a]	[a]	.....	.....
3	West Virginia	14	.....	[a]	2,577,766	[a]
23	Wisconsin	3	7,000	.....	.....	.....
	Other States [b]	.....	211,106	699,902	1,434,870	524,039
		[c] 412	1,059,904	3,349,301	14,968,079	2,384,686
	Percentage of pottery products	.....	2.99	9.46	42.29	6.74
	Percentage of total clay products	.....	.64	2.03	9.07	1.45
	Number of firms reporting each variety	.....	149	146	50	13

[a] Included in "Other States."
[b] Includes all products made by less than 3 producers in 1 State.
[c] Includes 23 firms not distributed.

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Value of pottery products in 1914—Continued.

Rank of State.	State.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.[a]	Total.	Percentage of total.
19	Alabama				$16,542	0.05
18	Arkansas			(b)	19,400	.06
8	California	$247,770		$15,962	345,803	.98
14	Colorado			27,600	61,257	.17
	Connecticut		(b)		(c)	
	District of Columbia				(c)	
17	Georgia				20,961	.06
7	Illinois	(b)	(b)	8,745	780,579	2.21
6	Indiana	739,132	(b)		1,152,078	3.25
16	Iowa			(b)	32,750	.09
	Kansas				(c)	
13	Kentucky				89,426	.25
	Louisiana			(b)	(c)	
	Maine				(c)	
11	Maryland	(b)		2,000	206,483	.58
10	Massachusetts			11,345	219,104	.62
9	Michigan	(b)	(b)	(b)	265,194	.75
	Minnesota				(c)	
20	Mississippi				15,060	.04
24	Missouri				2,944	.01
	Montana				(c)	
	Nebraska				(c)	
	New Hampshire			(b)	(c)	
2	New Jersey	5,058,204	$905,878	256,108	8,131,356	22.97
4	New York	(b)	940,029	54,851	2,155,792	6.09
21	North Carolina			(b)	12,796	.04
1	Ohio	619,931	1,472,359	1,138,725	15,351,376	43.37
	Oregon				(c)	
5	Pennsylvania	(b)	(b)	15,737	1,746,501	4.93
22	South Carolina				10,668	.03
12	Tennessee			(b)	97,195	.27
15	Texas			1,793	58,747	.17
	Utah				(c)	
	Virginia			(b)	(c)	
	Washington			(b)	(c)	
3	West Virginia	872,987	(b)		3,930,464	11.10
23	Wisconsin				7,000	.02
	Other States[d]	336,245	812,004	98,796	[e] 669,185	1.89
		7,874,269	4,130,270	1,631,652	35,398,161	100.00
	Percentage of pottery products	22.24	11.67	4.61	100.00	
	Percentage of total clay products	4.77	2.51	.99	21.46	
	Number of firms reporting each variety	46	37	65		

[a] Including aquarium ornaments, art and chemical pottery, craequle porcelain, faience, Guernsey earthenware, Hampshire, Niloak, Pewabic, Rookwood, Teco, and Walley pottery, jardinieres, mantle rings, Oxfordware, pins, stilts, and spurs for potters' use, porcelain door knobs, shuttle eyes and thread guides, porcelain hardware trimmings, porcelain interiors for refrigerators, tobacco pipes, toy marbles, turpentine cups, umbrella stands, vases, and water filters.

[b] Included in "Other States."

[c] Included in [d] ($669,185).

[d] Includes all products made by less than 3 producers in 1 State.

[e] Made up of State totals of Connecticut, District of Columbia, Kansas, Louisiana, Maine, Minnesota, Montana, Nebraska, New Hampshire, Oregon, Utah, Virginia, and Washington.

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Value of pottery products in 1915.

Rank of State.	State.	Number of firms reporting sales.	Red earthenware.	Stoneware and yellow and Rockingham ware.	Whitewear, including C. C. ware, white granite, semiporcelain ware, and semivitreous porcelain ware.	China, bone china, delft, and belleek ware.
19	Alabama	13	$6,741	$8,556	.....	.....
16	Arkansas	3	(a)	(a)	.....	.....
9	California	12	32,663	(a)	.....	.....
15	Colorado	5	(a)	(a)	.....	.....
	Connecticut	.....	(a)	(a)	.....	.....
	District of Columbia	.....	(a)	.....	.....	.....
17	Georgia	17	11,452	6,725	.....	.....
7	Illinois	21	40,810	572,958	(a)	.....
6	Indiana	11	3,818	44,551	(a)	.....
23	Iowa	3	(a)	(a)	.....	.....
	Kansas	.....	.....	(a)	.....	.....
12	Kentucky	7	43,839	65,000	.....	.....
	Louisiana	.....	(a)	.....	.....	.....
	Maine	.....	.....	(a)	.....	.....
10	Maryland	6	(a)	.....	(a)	.....
11	Massachusetts	8	(a)	(a)	(a)	.....
8	Michigan	6	112,863	.....	(a)	.....
	Minnesota	.....	(a)	(a)	.....	.....
18	Mississippi	3	835	14,855	.....	.....
24	Missouri	3	(a)	(a)	.....	.....
	Montana	.....	(a)	.....	.....	.....
	Nebraska	.....	(a)	.....	.....	.....
	New Hampshire	.....	.....	.....	.....	.....
2	New Jersey	54	34,600	91,815	665,633	983,855
4	New York	21	39,921	(a)	(a)	833,301
20	North Carolina	23	2,504	8,190	.....	.....
1	Ohio	104	336,038	1,864,450	10,184,834	.....
	Oregon	.....	(a)	(a)	.....	.....
5	Pennsylvania	22	176,791	228,205	(a)	(a)
	Porto Rico	.....	(a)	.....	.....	.....
21	South Carolina	5	7,581	(a)	.....	.....
13	Tennessee	9	3,975	21,704	.....	.....
14	Texas	16	14,723	50,666	.....	.....
	Utah	.....	(a)	.....	.....	.....
	Virginia	.....	.....	.....	.....	.....
	Washington	.....	(a)	.....	.....	.....
3	West Virginia	14	.....	.....	2,837,766	(a)
22	Wisconsin	3	8,359	.....	.....	.....
	Other States[b]	22	194,548	597,928	1,636,009	513,000
		[c]416	1,072,061	3,575,603	15,324,242	2,330,156
	Percentage of pottery products	.....	2.87	9.58	41.06	6.24
	Percentage of total clay products	.....	.66	2.19	9.39	1.43
	Number of firms reporting each variety	.....	156	136	57	14

[a] Included in "Other States."
[b] Includes all products made by less than 3 producers in 1 State.
[c] Includes 22 firms not distributed.

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Value of pottery products in 1915—Continued.

Rank of State.	State.	Sanitary ware.	Porcelain electrical supplies.	Miscellaneous.[a]	Total.	Percentage of total.
19	Alabama				$15,297	0.04
16	Arkansas			(b)	20,285	.05
9	California	$266,353		$34,862	368,094	.99
15	Colorado			25,585	62,885	.17
	Connecticut		(b)		(c)	
	District of Columbia				(c)	
17	Georgia				15,177	.05
7	Illinois	(b)	(b)	14,812	948,892	2.54
6	Indiana	757,115	(b)		1,198,034	3.21
23	Iowa			(b)	5,425	.01
	Kansas				(c)	
12	Kentucky				108,839	.29
	Louisiana			(b)	(c)	
	Maine				(c)	
10	Maryland	(b)	(b)	(b)	206,718	.55
11	Massachusetts			11,561	184,233	.49
8	Michigan		(b)	(b)	521,989	1.40
	Minnesota				(c)	
18	Mississippi				15,690	.04
24	Missouri				3,166	.01
	Montana				(c)	
	Nebraska				(c)	
	New Hampshire			(b)	(c)	
2	New Jersey	4,793,406	$1,028,992	451,037	8,049,338	21.57
4	New York	(b)	1,153,068	115,394	2,441,740	6.54
20	North Carolina			(b)	11,394	.03
1	Ohio	591,455	1,489,614	1,463,388	15,929,779	42.68
	Oregon				(c)	
5	Pennsylvania	(b)	(b)	23,220	1,827,749	4.90
	Porto Rico				(c)	
21	South Carolina				8,981	.02
13	Tennessee			(b)	106,389	.29
14	Texas				65,389	.18
	Utah				(c)	
	Virginia			(b)	(c)	
	Washington				(c)	
3	West Virginia	1,056,585	(b)	66,944	4,510,623	12.09
22	Wisconsin				8,359	.02
	Other States[d]	528,302	999,528	152,105	[e]687,923	1.84
		7,993,216	4,671,202	2,358,908	37,325,388	100.00
	Percentage of pottery products	21.42	12.51	6.32	100.00	
	Percentage of total clay products	4.90	2.86	1.45	22.88	
	Number of firms reporting each variety	43	40	70		

[a] Including aquarium ornaments, art pottery, casseroles, chemical stoneware, cuspidors, filter disks, jardinieres, cracqule porcelain, Guernsey earthenware, Hampshire, Niloak, Omar Khayyam, Pewabic, Rookwood, and Teco pottery, magnesia ware, mantle rings, Oxfordware, pins, stilts, and spurs for potters' use, porcelain door knobs, shuttle eyes, and thread guides, porcelain hardware trimmings, refrigerator linings, tobacco pipes, toy marbles, turpentine cups, umbrella stands, and vases.

[b] Included in "Other States."

[c] Included in [e] ($687,923).

[d] Includes all products made by less than 3 producers in 1 State.

[e] Made up of State totals of Connecticut, District of Columbia, Kansas, Louisiana, Maine, Minnesota, Montana, Nebraska, New Hampshire, Oregon, Porto Rico, Utah, Virginia, and Washington.

The number of States reporting ware classed in this report as pottery was 38 in 1915, an increase of 1, Porto Rico again entering the list of producers of pottery. The important producing States, especially those reporting the higher grades of ware, are few. White ware was reported from 10 States, an increase of 2, Massachusetts and Michigan; china was reported from 4 States, New Jersey, New York, Pennsylvania, and West Virginia, the same as for 1914; sanitary ware from 9 States, a decrease of 1, Michigan; and porcelain electrical supplies from 10 States, an increase of 1, Maryland.

Red earthenware, the commonest of pottery products, and at the same time the least important in total value, was reported from 33 States in 1915, an increase of 1, Porto Rico. Ohio was the leading State in 1915, as for many years, and reported a considerable increase over 1914. Pennsylvania and Massachusetts were second and third,

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respectively. These three States reported about 60 per cent of the total for 1915. The number of producers reporting red earthenware increased slightly in 1915.

There was a decrease of 3 States producing stoneware and yellow and Rockingham ware in 1915. They were Maryland, Washington, and West Virginia. Ohio showed a large increase in 1915, was the leading producer, and reported more than one-half of the entire output. Illinois was the second State in value of output, and showed a large increase in 1915.

The most important pottery products of the United States in value are grouped under the head of white ware. These include the various household wares and constituted in 1915 more than 41 per cent of the total value of all pottery products. These products were reported by 57 operators in 1915, an increase of 7. Notwithstanding this increased number of operators, there were less than three producers in each of 7 States; therefore, to prevent disclosing confidential information, totals for only 3 States are published. Ohio was the leading State in the production of these wares in 1915, as for many years, and reported nearly two-thirds of the total value. There was, however, a small decrease, $42,972, in the value of these wares in Ohio in 1915. West Virginia ranked second and showed an increase in value of $260,000, or 10 per cent, over 1914.

Comparatively little china is made in the United States, that for 1915 constituting only one-sixteenth of the value of all pottery reported. New Jersey was the leading State in the production and reported over 42 per cent of the total of this ware in 1915, but its product decreased in value $92,188, or nearly 9 per cent, compared with 1914. New York was the second State and showed an increase of $48,697, or 6 per cent. One more operator reported china in 1915 than in 1914.

New Jersey was the leading State in the production of sanitary ware in 1915, as for many years, and reported 60 per cent of the entire output. West Virginia was second and Indiana third. These relative ranks have been maintained for some years. New Jersey showed a decrease in value, and West Virginia and Indiana showed increase.

Porcelain electrical supplies were produced most largely in 1915 in Ohio, New York, and New Jersey, these three States, named in the order of their importance, reporting nearly 80 per cent of the output. Ohio showed a slight increase in the value of porcelain electrical supplies, and New York and New Jersey showed large increases. The number of operators reporting porcelain electrical supplies in 1915 was 40, an increase of 3 over 1914.

Ohio is the leading pottery-producing State of the Union, reporting for 1915 wares valued at $15,929,779, or nearly 43 per cent of the total, an increase of $578,403, or nearly 4 per cent, over 1914. Ohio's principal pottery product is white ware, which constituted nearly two-thirds of the value of the entire pottery output of the State in 1915. Ohio's second product in importance is stoneware. Ohio produced every variety of pottery as classified in this report but one—china. New Jersey is the second largest pottery-producing State. For 1915 it reported wares valued at $8,049,338, or nearly 22 per cent of the total, a decrease of $82,018, or 1 per cent, from 1914. The principal pottery product of New Jersey is sanitary

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ware, which constituted about 60 per cent of the State total in 1915. West Virginia is the third in rank among the pottery-producing States, and showed the largest increase in value of products in 1915—$580,159, or nearly 15 per cent. Its pottery wares were valued at $4,510,623, or nearly one-eighth of the total. West Virginia's principal pottery product is white ware, which constituted nearly 63 per cent of the State total in 1915. It is also a large producer of sanitary ware. New York was fourth and Pennsylvania was fifth, as for many years. Indiana and Illinois maintained their relative ranks of sixth and seventh, respectively. The value of pottery output in both of these States increased considerably in 1915 compared with 1914. The first five States, Ohio, New Jersey, West Virginia, New York, and Pennsylvania, made nearly 88 per cent of the total production in 1915.

New Jersey, New York, and Pennsylvania reported in 1915 every variety of pottery as classified in this report.

In considering the rank of States it should be borne in mind that the small number of producers in many of them in 1915, which made it impossible to publish State totals without disclosing individual returns, makes the rank of all but the first few the relative and not the actual rank.

CONSUMPTION.

The pottery imported into the United States in 1915 was valued at $6,628,086, and the pottery marketed was valued at $37,325,388, a total of $43,953,474. After deducting exports—domestic, $563,452 and foreign, $94,705—the net apparent consumption was valued at $43,295,317, of which the domestic production was 86 per cent. In 1914 this percentage was 82; in 1913 it was 80; in 1912 it was 81; in 1911 it was 79; in 1910 it was 77; and the next highest percentage was in 1902, when it was 73.

IMPORTS.

The total value of imports of all clay products decreased $1,806,350, or nearly 21 per cent in 1915; in 1914 there was a decrease of $1,887,528, or 18 per cent. The total value of imports for 1915 was the lowest since 1890 and was $7,011,045, or nearly 51 per cent, less than that of 1907, the year of maximum value. Of the imports for 1915 about 97 per cent was pottery and about 3 per cent was brick and tile. The value of pottery imports in 1915 decreased $1,770,507, or 21 per cent, and was less than half of the value of the pottery imported in 1907 In 1915 the imports of the higher grades of pottery constituted over 96 per cent of the total. Brick and tile imports decreased $35,843, or 17 per cent, in 1915.

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Value of clay products imported and entered for consumption in the United States, 1886–1915.

Year.	Pottery.							Brick, fire brick, tile, etc.	Grand total.
	Brown earthen and common stone ware.[a]	Tobacco pipes and pipe bowls of clay.	Earthenware and crockery composed of a nonvitrified absorbent body.		China and porcelain.		Total.		
			Not decorated.	Decorated.	Not decorated.	Decorated.			
1886	$37,820	.....	.....	.....	$865,446	$3,350,145	$4,253,411	$951,293	$5,204,704
1887	43,079	.....	.....	.....	967,694	3,888,509	4,899,282	1,008,360	5,907,642
1888	55,558	.....	.....	.....	1,054,854	4,207,598	5,318,010	886,314	6,204,324
1889	48,824	.....	.....	.....	1,148,026	4,580,321	5,777,171	788,391	6,565,562
1890	56,730	.....	.....	.....	974,627	3,562,851	4,594,208	563,568	5,157,776
1891	99,983	.....	.....	.....	1,921,643	6,288,088	8,309,714	353,736	8,663,450
1892	63,003	.....	.....	.....	2,022,814	6,555,172	8,640,989	380,520	9,021,509
1893	57,017	.....	.....	.....	1,732,481	6,248,255	8,037,753	338,143	8,375,896
1894	47,114	.....	.....	.....	1,550,950	5,392,648	6,990,712	189,631	7,180,343
1895	61,424	.....	.....	.....	2,117,425	8,055,473	10,234,322	211,473	10,445,795
1896	41,585	.....	.....	.....	1,511,542	7,729,942	9,283,069	247,455	9,530,524
1897	32,227	.....	.....	.....	1,406,019	7,057,261	8,495,507	146,668	8,642,175
1898	54,672	.....	.....	.....	1,002,729	5,905,209	6,962,610	117,324	7,079,934
1899	40,164	.....	.....	.....	1,125,892	6,740,884	7,906,940	134,691	8,041,361
1900	65,214	.....	.....	.....	1,059,152	7,617,756	8,742,122	169,951	8,912,073
1901	51,551	.....	.....	.....	1,094,078	8,385,514	9,531,143	150,268	9,681,411
1902	58,926	.....	.....	.....	1,016,010	8,495,598	9,570,534	235,737	9,806,271
1903	95,890	.....	.....	.....	1,234,223	9,897,588	11,227,701	228,589	11,456,290
1904	81,951	.....	.....	.....	1,329,146	9,859,144	11,270,241	218,170	11,488,411
1905	100,618	.....	.....	.....	1,157,573	10,717,871	11,976,062	172,079	12,148,141
1906	96,400	.....	.....	.....	1,312,326	11,822,376	13,231,102	175,797	13,406,899
1907	113,477	.....	.....	.....	1,315,591	12,156,544	13,585,612	225,320	13,810,932
1908	70,629	.....	.....	.....	1,142,444	9,309,718	10,522,791	162,341	10,685,132
1909	98,716	.....	.....	.....	1,245,479	9,263,017	10,607,212	189,536	10,796,748
1910	154,614	$52,077	.....	.....	1,293,986	9,682,558	11,183,235	222,183	11,405,418
1911	164,871	61,244	.....	.....	1,221,756	9,251,989	10,699,860	208,966	10,908,826
1912	152,166	66,292	.....	.....	1,094,152	8,309,212	9,621,822	215,379	9,837,201
1913	238,611	31,806	[b]$81,978	[b]$523,803	[c]1,067,209	[c]8,273,681	10,217,088	276,677	10,493,765
1914	312,934	40,548	438,460	1,968,561	727,725	4,910,365	8,398,593	207,644	8,606,237
1915	227,017	15,155	272,795	1,538,732	458,302	4,116,085	6,628,086	171,801	6,799,887

[a] Including Rockingham ware and miscellaneous pottery products.
[b] Figures cover period from Oct. 4 to Dec. 31.
[c] Including wares classified under the act of 1913 as china and porcelain wares composed of a vitrified nonabsorbant body: Not decorated, $244,933; decorated, $2,204,851. After 1913 only wares composed of a vitrified nonabsorbent body are included.

EXPORTS.

The value of exports of domestic clay products in 1915 decreased $872,765, or 24 per cent, from 1914. In 1914 there was a decrease of $1,210,234, or 25 per cent, from 1913. Of the exports in 1915, 57 per cent was brick and tile, 21 per cent pottery, and 22 per cent unclassified. The decrease was in the brick and tile and unclassified exports; the exports of pottery showed a small increase—$36,550, or nearly 7 per cent, and the exports of china showed an increase in value of $24,501, or 18 per cent, and reached their maximum value.

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Value of clay products of domestic manufacture exported from the United States, 1895–1915.

Year.	Building brick.	Fire brick.	Tile (except drain).	Earthen and stone ware.	China.	All other.	Total.
1895	$34,732	$88,729	.....	$114,425	$24,872	.....	$262,758
1896	32,759	102,636	.....	144,641	24,702	.....	304,738
1897	30,383	110,626	.....	177,320	30,283	.....	348,612
1898	32,317	146,632	.....	212,769	39,052	.....	430,770
1899	77,783	214,375	.....	467,925	43,807	.....	803,890
1900	128,800	594,237	.....	489,942	68,852	.....	1,281,831
1901	74,210	467,379	.....	476,957	49,863	.....	1,068,409
1902	31,304	470,130	.....	555,340	49,306	.....	1,106,080
1903	63,774	375,503	.....	527,689	61,312	.....	1,028,278
1904	179,866	407,519	.....	697,381	94,358	.....	1,379,124
1905	263,876	536,002	.....	882,069	101,485	.....	1,783,432
1906	247,625	637,441	.....	1,003,969	114,481	.....	2,003,516
1907	185,192	631,779	.....	1,022,730	108,911	.....	1,948,612
1908	.....	[a] 550,243	.....	906,266	77,494	$113,243	1,647,246
1909	.....	[a] 1,002,270	.....	776,842	86,853	147,622	2,013,587
1910	.....	[b] 634,775	.....	928,475	113,214	968,138	2,644,602
1911	.....	1,057,725	.....	1,278,892	122,474	1,206,029	3,665,720
1912	[b] 448,939	1,117,161	[b] $539,116	1,037,637	140,147	1,717,895	5,000,895
1913	689,515	1,121,590	851,463	410,050	149,281	1,566,340	4,788,239
1914	524,239	734,134	658,695	390,693	136,209	1,134,035	3,578,005
1915	279,336	975,089	276,785	297,127	160,710	610,578	[c] 2,705,240

[a] Includes all brick, other than building brick.
[b] Figures cover period from July 1 to Dec. 31.
[c] Includes $105,615 of sanitary ware.

Value of clay products of domestic manufacture exported from the United States in 1914 and 1915.

1914.

Destination.	Building brick.	Fire brick.	Tile (except drain).	Earthen and stone ware.	China.	All other.	Total.
Europe	$48	$34,414	$6,982	$26,489	$20,158	$33,133	$90,224
Central America and West Indies	38,281	137,375	246,105	39,938	21,523	349,552	832,774
Canada	476,124	473,380	283,149	275,038	73,837	649,480	2,231,008
Mexico	6,432	28,665	2,000	3,185	4,899	15,439	60,620
Newfoundland	100	103	1,293	236	287	851	2,870
South America	3,166	56,893	79,973	32,118	5,075	44,225	221,450
Asia	.....	5,318	3,851	8,127	5,131	4,185	26,612
Oceania	88	27,842	35,223	5,141	2,457	34,186	104,937
Africa	.....	1,144	119	421	2,842	2,984	7,510
	524,239	734,134	658,695	390,693	136,209	1,134,035	3,578,005

1915.

Destination.	Building brick.	Fire brick.	Tile (except drain).	Earthen and stone ware.	Sanitary earthenware.	China.	All other.	Total.
Europe	$5,634	$81,583	$5,547	$16,935	$2,277	$16,691	$38,949	$167,616
Central America and West Indies	35,891	119,588	85,553	39,553	27,867	44,930	200,746	554,128
Canada	207,217	644,437	112,396	207,189	26,736	41,372	285,091	1,524,438
Mexico	10,614	38,248	2,397	4,330	2,803	6,576	23,434	88,402
Newfoundland	2,182	1,608	1,643	1,862	336	500	6,700	14,831
South America	13,711	66,155	35,420	18,375	36,465	17,231	30,203	217,560
Asia	3,750	13,048	6,575	4,050	3,058	6,335	11,305	48,121
Oceania	102	9,308	27,254	4,482	6,073	26,668	14,026	87,913
Africa	235	1,114	.....	351	.....	407	124	2,231
	279,336	975,089	276,785	297,127	[a] 105,615	160,710	610,578	2,705,240

[a] Figures cover period from July 1 to Dec. 31.

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Canada is the greatest market for clay products exported from the United States, 56 per cent of such wares going to that country in 1915—a decrease of $706,570, or nearly 32 per cent from 1914. Central America and the West Indies are the next best customers, these countries taking over 20 per cent of the total in 1915. South America was third, the total value of exports to that grand division showing a small decrease compared with 1914.

CLAY PRODUCTS BY STATES.

In the following pages the statistics of the clay-working industries are given for some of the principal producing States. For tabular statements for these States for 1914 and other years the reader is referred to previous volumes of Mineral Resources.

ALABAMA.

The clay products of Alabama in 1915 were valued at $1,193,022—brick and tile, $1,177,725; pottery, $15,297—a decrease of $381,001. Its principal clay product was common brick, valued at $382,092, or 32 per cent of the State total, a decrease of $256,754 from 1914. The quantity of common brick reported for 1915 was 70,681,000 brick, a decrease of 40,050,000 brick. Common brick was closely followed by vitrified brick or block, valued at $374, 387, an increase of $125,862. The quantity of vitrified brick marketed in 1915 was 29,018,000 brick, an increase of 10,339,000 brick or block. Alabama ranked twenty-fourth in 1915 among the States in value of clay products, and 65 operators reported sales.

Jefferson County was the principal clay-working county, and reported a production valued at $815,338, or 68 per cent of the State's total value in 1915, a decrease of $213,797. Nearly all of the fire brick produced in the State comes from Jefferson County. Jefferson County is also the only producer of vitrified brick or block. The principal producing counties of common brick, named in the order of the value of output, were: Jefferson, Montgomery, Russell, and Talladega.

CALIFORNIA.

California is one of the important clay-working States, ranking tenth in value of clay products in 1915. It was tenth in value of common brick, ninth in value of front brick, fourth in sewer pipe and terra cotta, eighth in fireproofing, and sixth in value of fire brick. California reported for 1915 every variety of ware, as classified in this report, except silica fire brick, white ware, china, and porcelain electrical supplies. There were 82 operators who reported sales for 1915.

The total value of California's clay products in 1915 was $3,599,375—brick and tile, $3,231,281; pottery, $368,094—a decrease of $862,286. California's principal clay product, common brick, made chiefly in Los Angeles and Contra Costa counties, was valued in 1915 at $981,888, or 27 per cent of the value of all clay products in the State, a decrease of $374,997. Sewer pipe made principally in Los Angeles and Alameda counties, was second in value, $707,480, a decrease of $251,713 from 1914. California's principal pottery

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product is sanitary ware, valued at $266,353 in 1915, an increase of $18,583 over 1914.

Los Angeles, the principal common-brick producing county, reported 76,996,000 brick, valued at $435,971, or 48 per cent of the quantity and 44 per cent of the value of the common brick of the State in 1915—a decrease of 35,021,000 brick and $182,759. The principal product of Los Angeles County was common brick and sewer pipe was second, these two constituting considerably over half of the value of the county's clay products in 1915. Front brick, fireproofing, tile, not drain, and fire brick are also produced in this county to a considerable value. Contra Costa was the leading pottery-producing county, reporting 72 per cent of the value of pottery for the State. Sanitary ware is its principal pottery product. Los Angeles was also the leading clay-working county, reporting wares valued at $1,317,586, a decrease of $420,364 from 1914.

COLORADO.

The total value of Colorado's clay products in 1915 was $1,265,105—brick and tile, $1,202,220; pottery, $62,885—an increase of $121,163. Colorado's principal clay product in 1915 was fire brick, which was valued at $256,059, an increase of $46,691 over 1914, and displaced common brick by a small margin. Colorado ranked twenty-third among the States in the value of clay products in 1915, its production being reported by 58 operators.

Denver County was the chief producer of common brick, reporting 18,214,000 brick valued at $117,496 in 1915, an increase of 1,031,000 brick and $20,683 over 1914. Denver is also the principal pottery-producing county, reporting over one-half of the State's total. Fire brick was produced most largely in Peublo County, with Denver County second. Denver is the principal clay-working county, reporting wares valued at $720,781, or 57 per cent of the State's total for 1915. This was an increase of $87,074 over 1914.

CONNECTICUT AND RHODE ISLAND.

There being but two producers in Rhode Island, it is impossible to publish figures for the State without disclosing confidential returns and they are combined with those of Connecticut. The value of the brick and tile products of these two States in 1915 was $1,518,773, an increase of $289,736 over 1914. Connecticut's products were common brick, front brick, fireproofing, stove lining, fire brick, and pottery. Rhode Island reported common, vitrified, and fancy brick, and tile, not drain. Common brick, valued at $1,382,087, constituted 91 per cent of the total value of the brick and tile products of the two States in 1915, an increase of $241,245. Hartford is the leading county in Connecticut. It reported brick and tile products valued at $719,105, or more than one-half of the value of the entire States, and reported also more than one-half of the quantity and value of common brick marketed in these States in 1915. New Haven and Middlesex Counties are also large producers of common brick. Fire brick is made only in New Haven County.

These States were twentieth in the value of clay products in 1915; 38 active operators reported for that year.

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GEORGIA.

The total value of clay products in Georgia in 1915 was $1,845,019—brick and tile, $1,826,842; pottery, $18,177—a decrease of $418,015. In 1915, Georgia was tenth in the production of common brick and sixth in the value of sewer pipe. The principal product was common brick, valued at $801,202, a decrease of $239,355 from 1914; the quantity was 158,465,000 brick, a decrease of 56,514,000 brick. The average price per thousand increased 22 cents to $5.06. The value of common brick constituted 43 per cent of all clay products of the State. Sewer pipe ranked second in importance, being valued at $567,118, a decrease of $80,615.

Bibb County was the leading producer of common brick and sewer pipe and reported 46,177,000 brick, valued at $197,066, a decrease of 22,478,000 brick and $82,872. Fulton and Richmond counties were also large producers of common brick. Architectural terra cotta was reported only from Fulton County. Bibb County was the leading clay-working county and reported wares for 1915 valued at $452,023, a decrease of $93,753. No pottery was produced in Bibb County.

Georgia was the fifteenth State in the value of clay products, which were reported by 70 operators in 1915.

ILLINOIS.

Illinois makes every variety of clay product, as classified in this report, except china. It ranked fourth in the value of all clay products in 1915, third in brick and tile products, and seventh in pottery. It was the leading State in the value of common brick, second in the value of vitrified brick or block, of terra cotta and stoneware, and of silica fire brick; third in enameled brick; fourth in front brick and draintile; fifth in sewer pipe and fireproofing; eighth in clay fire brick, and seventh in sanitary ware. There were 247 operators who reported sales of clay products in 1915.

The total value of clay products in Illinois in 1915 was $14,791,938—brick and tile, $13,843,046; pottery, $948,892—or 9 per cent of the total for the country, an increase of $1,472,985. The principal product of the State is common brick, the production of which was 1,066,057,000 brick, valued at $6,870,990, or $6.45 per thousand, an increase of 124,714,000 brick and $1,972,292. Of the common brick Cook County reported 739,173,000 brick, valued at $4,794,452, or $6.49 per thousand, an increase of $2.04 per thousand. This is the largest brick-making county in the country and is the second largest common brick-making center of the United States, being surpassed in output and value only by the Hudson River region of New York. In value the output of common brick of Cook County exceeded the value in the New York portion of the Hudson River region in 1915 by $1,049,904, owing to the much higher price ($1.44) per thousand obtained in Cook County. The average price per thousand for common brick in Illinois in 1915 was $6.45, or $1.25 higher than in 1914. Second in importance was vitrified brick or block, of which 142,689,000 were reported for 1915, valued at $1,796,350, a decrease of 14,487,000 brick or block in quantity and of $289,994 in value. The average price per thousand for vitrified

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brick or block declined 68 cents in 1915. Of this output 119,408,000 brick or block, valued at $1,606,417, or $13.45 per thousand, were sold for paving and 23,281,000 brick, valued at $189,933, or $8.16 per thousand, were sold for other purposes. Knox County, in which Galesburg is situated, was the leading county in the production of vitrified brick or block, with Livingston County second. Architectural terra cotta, the third product produced most largely in Cook County, was reported to the value of $1,289,848, a decrease of $363,097. Vermilion was the leading county in the production of front brick. Kankakee County was the only producer of enameled brick. La Salle County led in the production of draintile, fireproofing, and fire brick. McDonough County produced chiefly sewer pipe.

Stoneware, valued at $572,958, was Illinois's principal pottery product, made chiefly in Warren and McDonough Counties.

Cook County, owing to the large local market, was the leading clay-working county in the State, and reported wares valued at $5,877,607, or 40 per cent of the State's total in 1915, an increase of $1,784,866 over 1914. La Salle County was second, with a production valued at $936,485. The principal clay products of this county are fireproofing, fire brick, and draintile.

INDIANA.

Indiana is one of the most important clay-working States, ranking sixth in value of products, which were reported by 221 operators in 1915. It reported every variety of product, as classified in this report, except enameled brick, stove lining, and china. It was third in value of front brick and silica fire brick; third in value of draintile and tile, not drain; fourth in fireproofing; fifth in white ware; sixth in vitrified brick or block; and seventh in sewer pipe.

The total value of Indiana's clay products in 1915 was $7,090,630—brick and tile, $5,892,596; pottery, $1,198,034—a decrease of $564,655. Draintile was Indiana's principal clay product, valued at $1,253,805 in 1915, a decrease of $78,197. Its value constituted 18 per cent of the total for the State. Vigo was the principal producer of draintile, displacing Madison County in 1915. Common brick, the clay product of second importance, showed a decrease of 42,737,000 brick and $259,711 from 1914. Lake County was the principal producer of common brick and was the second county in the value of all clay products. Clay County is the principal producer and reported clay wares for 1914 valued at $1,347,855, an increase of $102,002 over 1914. Sanitary ware is the principal pottery product of Indiana, being valued at $757,115 in 1915, an increase of $17,983 over 1914.

IOWA.

Iowa ranked seventh in the value of clay products. The total value of these wares in 1915 was $6,743,615—brick and tile, $6,738,190; pottery, $5,425—an increase of $341,870. In 1915 Iowa was the leading State in the value of draintile, the principal clay product of the State; third in value of fireproofing; fourth in stove lining; eighth in sewer pipe; and tenth in vitrified brick or block. Draintile constituted 56 per cent of the total and was valued at $3,802,599 in 1915, an increase of $621,763 over 1914. Fireproofing

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was the clay product of second importance in Iowa in 1915, and was valued at $1,008,457, a decrease of $74,940. Common brick was third among Iowa's clay products in 1915 and showed a decrease of $168,895 from 1914. The quantity of common brick decreased 17,782,000 brick.

Cerro Gordo County is the leading producer of draintile and reported a value of $1,417,908, or over one-third of the State's total, an increase of $426,975 over 1914. Webster County was second, reporting draintile valued at $696,829, an increase of $75,545 over 1914 Woodbury County is the largest producer of common brick.

Cerro Gordo was the leading county and reported clay wares valued at $1,830,220, an increase of $274,276 over 1914. Webster County, whose principal product also is draintile, was second with a value of $1,256,981, an increase of $77,868 over 1914.

One hundred and sixty-one active operators reported for 1915.

KANSAS.

The total value of brick and tile products in Kansas in 1915 was $2,110,877, an increase of $204,916 over 1914. Kansas ranked thirteenth among the States in the value of clay products in 1915; it was fifth in value of vitrified brick, seventh in front brick, and eighth in tile, not drain. Vitrified brick is the leading clay product of Kansas, followed by common brick. The quantity of vitrified brick marketed in 1915 was 47,511,000 brick, valued at $608,599, a decrease of 3,196,000 brick, but an increase in value of $14,370, the average price per thousand increasing $1.09 to $12.81. The quantity and value of common brick increased in 1915, the former by 3,909,000 brick and the latter by $12,580.

The principal vitrified brick-producing counties in Kansas in 1915, given in the order of the value of production, were Wilson, Montgomery, and Crawford. These three counties reported vitrified brick valued at $597,400, or 98 per cent of the State's total. Wilson County was the largest producer of common brick in 1915, reporting 38,641,000 brick, valued at $148,308, though Allen County's output of 36,640,000 was valued at $154,165. Neosho County was third in production and value.

Montgomery was the leading clay-working county in 1915, displacing Wilson County, its products being valued at $645,063, or 31 per cent of the State's total, an increase of $120,581 over 1914. Montgomery County's leading clay products in 1915 were vitrified brick or block, front brick, tile, not drain, retorts and condensers, and fireproofing. Wilson County's principal clay products were vitrified brick, front brick, and common brick.

There were 43 active operators in 1915.

KENTUCKY.

The value of Kentucky's clay products in 1915 was $2,441,290—brick and tile, $2,332,451; pottery, $108,839—an increase of $64,884. Kentucky was fourth in value of fire brick, fifth in tile, not drain, and ninth in draintile. Kentucky's leading clay product is fire brick, valued at $1,325,804 in 1915, an increase of $250,646 over 1914. The quantity of 9-inch equivalent fire brick marketed in Kentucky in 1915 was 77,170,000 brick, an increase of 18,390,000 brick. The value of

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fire brick constituted 54 per cent of the value of Kentucky's clay products in 1915. Common brick was second in importance, 74,807,000 being reported for 1915, valued at $479,506, a decrease of 15,317,000 brick and of $115,008. Tile, not drain, valued at $205,184 was third in importance. Kentucky's production of pottery, mostly stoneware, was valued at $108,839, an increase of $19,413.

Kentucky ranked twelfth in the value of clay products in 1915 and there were 78 active operators reporting.

Carter County is the chief producer of fire brick, reporting 48,639,000 9-inch equivalent brick, valued at $850,241, or 64 per cent of the output and value of fire brick of the State. This was an increase of 13,558,000 brick in quantity and of $193,586 in value. Fire brick was the only clay product made in Carter County in 1915. Boyd County was second in value of fire brick in 1915, displacing Jefferson County. Jefferson County ranked second in the quantity of fire brick but was third in its value, and was the leading county in the production of common brick, reporting 21,076,000 brick, valued at $131,563 for 1915, a decrease of 1,460,000 brick and $25,299 from 1914. The price of common brick per thousand in Jefferson County in 1915 decreased 72 cents to $6.24.

The pottery products of Kentucky in 1915 consisted of red earthenware and stoneware, made most largely in Jefferson and McCrackin counties.

Carter County was the leading county in the value of clay products in 1915, Jefferson being second with wares valued at $491,549. These two counties reported over one-half of the value of clay products of the State in 1915. Boyd County was third.

MARYLAND.

Maryland's clay products were valued in 1915 at $1,576,456—brick and tile, $1,369,738; pottery, $206,718—a decrease of $270,044. Maryland ranked eighteenth among the States in the value of clay products in 1915, with 43 active operators reporting for that year. Maryland ranked sixth in value of stove lining, eighth in white ware, and tenth in fire brick in 1915. Maryland's clay product of most importance was common brick, valued at $834,129, a decrease of $346,272 from 1914. The quantity of common brick in 1915 was 115,814,000, a decrease of 31,046,000 brick from 1914. The average value per thousand decreased 84 cents to $7.20. The value of common brick constituted 53 per cent of the value of all of Maryland's clay products in 1915. Fire brick ranks second among Maryland's clay products, 11,808,000 9-inch equivalent brick being reported, valued at $226,090, a small decrease in both quantity and value

Maryland ranked tenth in the value of pottery in 1915. White ware is its principal pottery product. Red earthenware, sanitary ware, and porcelain electrical supplies were also reported from Maryland for 1915.

The chief center of production of common brick was Baltimore City and Baltimore County. These two localities reported 83,384,000 brick, valued at $600,990, or 72 per cent of the quantity and value for the State. This was a decrease of 26,685,000 brick and of $312,677 from 1914. Allegany County was the leading fire-brick producing county.

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Baltimore City and Baltimore County constitute the principal clay-working center of the State and reported products valued at $1,000,257, or 63 per cent, of the State total for 1915, a decrease of $206,286. Baltimore County was the leading county in 1915, reporting wares valued at $680,151, and Allegany County was second, with wares valued at $347,334, displacing Baltimore City.

MASSACHUSETTS.

The value of clay products in Massachusetts in 1915 was $1,583,604—brick and tile, $1,399,371; pottery, $184,233—a decrease of $97,953. Massachusetts ranked first in value of stove lining, third in red earthenware, ninth in common brick, and tenth in tile, not drain, in 1915. Massachusetts ranked seventeenth in the value of clay products, which were reported by 59 active operators in 1915. The chief clay product of Massachusetts is common brick, which was valued at $1,026,179 in 1915, or 65 per cent of the value of the clay products of the State. The quantity reported was 144,520,000 brick. This was a small increase in both quantity and value over 1914. Stove lining was second among the clay products of Massachusetts, being valued at $161,795 in 1915, a slight increase over 1914. This State reported 35 per cent of the value of stove lining for the entire country in 1915. Red earthenware is the principal pottery product. Stoneware and white ware were also reported from this State in 1915.

Middlesex County was the leading county in the production and value of common brick in 1915, with Hampden Couuty second and Plymouth third.

Middlesex County is the leading clay-working county, reporting wares valued at $383,102, or nearly one-fourth of the production of the State.

MICHIGAN.

The value of Michigan's clay products in 1915 was $2,770,057—brick and tile, $2,248,068; pottery, $521,989—an increase of $69,991. Michigan ranked eleventh in 1915 in the value of clay products, 85 operators reporting sales, fifth in value of draintile and porcelain electrical supplies, sixth in common brick, and seventh in white ware.

Michigan's leading clay product is common brick. In 1915, 277,399,000 common brick were reported, valued at $1,461,188, an increase in quantity of 8,245,000 brick but a decrease in value of $172,028. The average price per thousand decreased 80 cents in 1915. The value of common brick was 53 per cent of the value of all clay products in the State in 1915. Draintile ranked second in importance and was reported to the value of $305,156, a decrease of $116,785 from 1914. Michigan's chief pottery product was porcelain electrical supplies; red earthenware and white ware were also produced there in 1915.

Wayne County, in which Detroit is located, led in production of common brick, reporting 225,015,000 brick, valued at $1,159,616, or about 80 per cent of the production and value of common brick for the State in 1915, a small increase in quantity but a decrease in value compared with 1914. The average price per thousand of common brick in this county declined 94 cents to $5.15 in 1915. Wayne County

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was the third largest common-brick producing center of the country in 1915. It was also the leading clay-working county in Michigan reporting for 1915 products valued at $1,531,352, or 55 per cent of the total value of the State, a decrease of $120,201, from 1914. Eaton County, the second in value of all clay products, is also the principal draintile-producing county. Sewer pipe was its principal clay product in 1915.

MINNESOTA.

The value of clay products in Minnesota in 1915, exclusive of pottery, was $1,645,913, a decrease of $298,973. Minnesota ranked sixth in value of draintile, tenth in sewer pipe, and tenth in front brick. The principal clay product is common brick, of which 107,473,000 brick, valued at $675,146, were reported for 1915, a decrease of 25,215,000 brick and of $208,645. The value of common brick constituted 41 per cent of all of Minnesota's brick and tile products in 1915. Sewer pipe ranks second, but, as it was reported by less than three producers, figures are not published. Draintile was third, valued at $255,347, an increase of $112,153.

Carver County was the largest producer of common brick in 1915, with Carlton County second and Hennepin third.

Goodhue was the leading clay-working county in the State; Carver was second and Hennepin third.

MISSOURI.

Missouri is one of the most important clay-working States, ranking ninth in the value of clay products in 1915. It reported in 1915 every variety of brick and tile product, as classified in this report. In 1915 it was the second State in value of sewer pipe and enameled brick, third in fire brick, fifth in fancy brick, sixth in front brick, sixth in terra cotta, seventh in draintile, ninth in tile, not drain, and ninth in vitrified brick or block.

The total value of the clay products of Missouri in 1915 was $5,431,569—brick and tile, $5,428,403; pottery, $3,166—a decrease of $645,715 from 1914. Fire brick is the product of chief value, 99,945,000 9-inch equivalent clay fire brick, valued at $1,922,738, being reported for 1915, an increase of 23,768,000 brick and of $368,307. The value of clay fire brick constituted 35 per cent of the total value of clay products. Sewer pipe was second in value, $1,012,337, a decrease of $223,899. Common brick was third, valued at $898,446, a decrease of $259,406. The quantity of common brick reported was 135,044,000, a decrease of 33,985,000 brick from 1914.

St. Louis County led in the production of fire brick in 1915, reporting 38,022,000 9-inch equivalent brick, an increase of 8,850,000 brick. St. Louis City was second, with a production of 30,711,000 brick, an increase of 4,484,000. In value of fire brick in 1915, however, St. Louis City was first, its output being valued at $746,924, an increase of $94,947, and St. Louis County was second, with a value of $709,912, an increase of $152,663. These two localities produced 69 per cent of the quantity of fire brick of the State and 76 per cent of its value. They also led in the production and value of common brick, St. Louis City reporting 58,460,000 brick, valued at $378,565, and St. Louis County reporting 28,730,000 brick, valued at $196,096, both considerable decreases. These two localities reported about 64 per cent of

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the quantity and value of common brick for the State. St. Louis City is also the leading producer of every other variety of clay product except fireproofing and stove lining. Jackson County was the leading producer of fireproofing, and Audrain County the only producer of stove lining. St. Louis City was the only producer of tile, not drain, and silica fire brick.

St. Louis City is the leading clay-working district in the State and reported for 1915 wares valued at $2,884,125, or 53 per cent of the State total. St. Louis County was second with wares valued at $964,523, or 18 per cent of the State total. Jackson County was third, Audrain fourth, and Henry fifth.

There were 89 operators who reported sales for 1915.

NEW JERSEY.

New Jersey ranks third in the value of clay products. It reported for 1915 every variety of clay product, as classified in this report, except vitrified brick or block. It was second in the value of pottery products and fourth in the value of brick and tile products. In 1915 it was first in value of china, sanitary ware, enameled brick, and terra cotta; second in fireproofing and tile, not drain; third in porcelain electrical supplies; fourth in white ware; fifth in common brick; and fifth in front brick.

The value of New Jersey's clay products in 1915 was $15,965,418—brick and tile, $7,916,080; pottery, $8,049,338—a decrease of $519,234, principally in the brick and tile industries. New Jersey's leading clay product is sanitary ware, valued at $4,793,406 in 1915, a decrease of $264,798. This ware constituted 30 per cent of the total value of New Jersey's clay products in 1915.

Common brick was second, valued at $2,099,654, an increase of $154,848. The quantity of common brick reported for 1915 was 354,104,000 brick, a small increase. Terra cotta ranked third, valued at $1,430,968, a decrease of $189,823. Fireproofing was fourth, valued at $1,389,120, a decrease of $210,175. Tile, not drain, and fire brick are also important products of this State, being valued at $995,097 and $899,613, respectively.

There were 149 operators reporting sales for 1915.

Mercer County, in which Trenton is located, is the most important clay-working county in the State, and its leading product is sanitary ware, which was reported to the value of $4,002,518 in 1915, or 25 per cent of the State's total for all clay products, a decrease of $374,147 from 1914. The value of all of the Mercer County clay products in 1915 was $7,036,263—brick and tile, $403,533; pottery, $6,632,730—or 44 per cent of the State's total, a decrease of $652,003, principally in pottery. Mercer County leads in the production of every variety of pottery, except red earthenware and stoneware, none of which is produced in that county. Middlesex County was second in importance as a clay-working county, its production being valued at $6,386,189—brick and tile, $5,653,398; pottery, $732,791—or 40 per cent of the State's total, a small increase over 1914. Middlesex was the leading producer of every variety of brick and tile product except sewer pipe and vitrified brick or block of which it produced none.

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NEW YORK.

New York ranks fifth in the value of clay products and reported for 1915 every variety of ware, as classified in this report, except enameled brick and silica brick. It ranked fifth in the value of brick and tile products and fourth in pottery. Its most interesting feature is the remarkable production of common brick along Hudson River, the largest brick-producing region in the country and probably in the world. New York was the second State in 1915 in the production and value of common brick, Illinois being first. It was also second in value of china and porcelain electrical supplies, third in terra cotta and stove lining, sixth in white ware, and seventh in vitrified paving brick and fire brick.

The value of clay products in New York in 1915 was $9,489,002—brick and tile, $7,047,262; pottery, $2,441,740—an increase of $410,069. Common brick is New York's principal clay product. For 1915, 980,580,000 common brick, valued at $5,157,677 were marketed, an increase of 71,712,000 brick and $491,640 over 1914. About three-fourths of this production and value came from the Hudson River region. The value of common brick constituted 54 per cent of all New York's clay products in 1915. Porcelain electrical supplies ranks second among New York's clay products and were valued at $1,153,068 in 1915, an increase of $213,039. China was third, valued at $833,301, an increase of $48,697. Terra cotta ranked fourth, valued at $647,816, a decrease of $241,652.

Ulster County was the leading county in the production of common brick, followed by Dutchess, Rockland, Orange, and Albany.

New York's principal pottery product is porcelain electrical supplies; china was the second pottery product. White ware is also made there in large quantities.

Onondaga County, owing to its large pottery production, was the leading county in the value of clay products in 1915, reporting ware valued at $1,277,908—pottery, $1,116,606; brick and tile, $161,302—an increase of $199,533. Ulster, whose only clay product is common brick, was second in vlaue of clay products; Erie was third; Kings fourth; and Albany fifth. Onondaga, Ontario, and Schenectady counties are the principal producers of porcelain electrical supplies and reported together in 1915 a production valued at $919,727, or 80 per cent of the State total for this variety.

The operators reporting sales for 1915 numbered 192.

NORTH CAROLINA.

The value of clay products in North Carolina in 1915 was $1,089,935—brick and tile, $1,078,541; pottery, $11,394—a decrease of $370,855, or 25 per cent. The chief product of North Carolina is common brick, of which 140,257,000 brick were reported for 1915, valued at $862,391, a decrease of 43,391,000 brick and of $353,789, and whose value constituted 79 per cent of all clay products in 1915. Front brick and drain tile were also made in small quantities; sewer pipe was made in considerable quantity by one operator.

Wayne County is the principal producer of common brick and reported 11,247,000 brick, valued at $68,000, a decrease of 14,435,000 brick and of $109,775. Craven County was second and Austin County third.

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Guilford is the principal clay-working county in the State and reported for 1915 products valued at $231,813, a decrease of $17,450. Common brick, draintile, sewer pipe, and fireproofing were reported from this county in 1915. Wayne County was second in the value of all clay products in 1915.

OHIO.

Ohio was the leading State in the Union in the value of clay products in 1915, both in brick and tile and in pottery. It reported all brick and tile products, as classified in this report, except enameled brick and terra cotta and all pottery products except china. It was the leading State in 1915 in value of vitrified brick, sewer pipe, fireproofing, tile, not drain, red earthenware, stoneware, white ware, and porcelain electrical supplies; second in front brick and fire brick; second in fancy brick and draintile; fourth in common brick and sanitary ware.

The value of its clay products in 1915 was $36,839,621—brick and tile, $20,909,842; pottery, $15,929,779—nearly 23 per cent of the total for the country, a decrease of $327,147.

Ohio's principal product is white ware, which was valued at $10,184,834, or 28 per cent of the total, and a decrease of $42,972. Vitrified brick or block was the second product and was valued at $4,017,758, an increase of $335,528. The quantity of vitrified brick reported for 1915 was 333,288,000, an increase of 39,907,000 brick or block. Of this output 295,475,000 brick, valued at $3,706,568, or $12.54 per thousand, were sold for paving and 37,813,000 brick, valued at $311,190, or $8.23 per thousand, were sold for other purposes. Sewer pipe was the third product and was valued at $3,719,790, a decrease of $971,929 from 1914. The fourth product, common brick, of which 422,292,000 were reported, valued at $2,604,602, showed a decrease of 13,825,000 brick and of $257,507. Common brick is followed in order by tile, not drain, fireproofing, fire brick, front brick, stoneware, porcelain electrical supplies, and draintile.

Stoneware, Ohio's second pottery product, valued at $1,864,450, increased $272,348 in 1915 and porcelain electrical supplies, Ohio's third pottery product, showed a slight increase of $17,255.

There were 524 operators who reported sales for 1915.

Sewer pipe was produced most largely in 1915 in Summit and Tuscarawas counties, in the order named, these two counties reporting 64 per cent of the total for the State. The leading county in the production and value of vitrified brick or block was Stark, with Cuyahoga second, Athens third, and Scioto fourth. In value of output, however, Stark was first, Cuyahoga second, Scioto third, and Athens fourth. Cuyahoga was the leading county in the production of common brick in 1915 and reported 147,124,000 brick, valued at $896,336, or about 35 per cent of the production and value of the entire State, and an increase of 19,674,000 brick and of $106,547. The city of Cleveland furnishes the principal market for this output. Lucas County was second.

Columbiana, the most important clay-working county in Ohio, is the principal producer of white ware. The clay products of this county in 1915 were valued at $7,283,770—pottery, $6,796,484; brick and tile, $487,286—or 20 per cent of the State's total, a decrease

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of $321,142. The value of its white ware output in 1915 was $5,887,372, or 58 per cent of the State's total for this variety, a decrease of $239,447. Muskingum, the second county in the State in the value of clay products, reported wares valued at $3,797,334—pottery, $1,609,025; brick and tile, $2,188,309—or 10 per cent of the State's total, an increase of $317,374. Muskingum's principal brick and tile product was tile, not drain, and its principal pottery product was stoneware. Summit County was third, reporting wares valued at $3,320,387—brick and tile, $2,033,329, principally sewer pipe; pottery, $1,287,058—an increase of $11,522. Mahoning County, fourth in value of clay products, reported for 1915 wares valued at $2,871,373—brick and tile, $259,355; pottery, $2,612,018. The chief pottery product was white ware, valued at $2,486,018, and the principal brick and tile product was front brick.

PENNSYLVANIA.

Pennsylvania ranks second in the value of clay products, reporting for 1915 every variety of ware as classified in this report, except enameled brick. It was second in value of brick and tile products and fifth in pottery, and 352 operators reported sales for 1915. In 1915 it was first in value of front and fire brick; second in stove lining and red earthenware; third in common brick and vitrified brick or block; third in sewer pipe, white ware, and china; fourth in fancy brick, tile, not drain, and stoneware; and fifth in terra cotta.

Pennsylvania's clay products in 1915 were valued at $22,726,031—brick and tile, $20,898,282; pottery, $1,827,749—an increase of $879,035 over 1914. This total was nearly 14 per cent of all clay products of the country.

Pennsylvania's clay product of greatest value is fire brick. Silica fire brick included, Pennsylvania marketed 471,390,000 9-inch equivalent fire brick in 1915, valued at $9,088,950, or $19.28 per thousand, an increase of 74,871,000 brick and of $1,252,447. Of the clay fire brick, Pennsylvania reported 379,042,000 9-inch equivalent brick, valued at $7,177,629, or $18.94 per thousand, an increase of 80,859,000 brick and of $1,402,952. It reported 92,348,000 9-inch equivalent silica fire brick, valued at $1,911,321, or $20.70 per thousand, a decrease of 5,988,000 brick and of $150,505. Pennsylvania reported about half of the fire brick produced in the entire country, and its value was 40 per cent of the State's total for all clay products. Pennsylvania's clay product second in value is common brick. The quantity reported for 1915 was 677,291,000 brick, valued at $4,515,296, or $6.67 per thousand, a decrease of 10,887,000 brick and of $125,973. Pennsylvania's third product was front brick, whose output in 1915 was 244,781,000 brick, valued at $2,631,795, an increase of 24,858,000 brick and of $229,434. Vitrified brick or block was fourth, 124,354,000 brick or block being reported, valued at $1,638,518, or $13.18 per thousand, a decrease of 26,846,000 brick or block and of $414,158. Of this output 112,393,000 brick or block, valued at $1,537,632, or $13.68 per thousand, were for paving, and 11,961,000, valued at $100,886, or $8.34 per thousand, were for other purposes.

White ware is Pennsylvania's principal pottery product, followed by china, sanitary ware, stoneware, red earthenware, and porcelain electrical supplies.

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Philadelphia County, the fourth largest common brick center of the country, with the city of Philadelphia as a market, is the principal producer in Pennsylvania of common brick, and reported 205,822,000 brick for 1915, valued at $1,385,987, an increase of 23,441,000 brick and of $97,520, and Allegheny County, the home of "Greater Pittsburgh," was second with 93,466,000 brick, valued at $646,571 in 1915, a decrease of 19,628,000 brick and of $121,092. Lawrence County was the principal vitrified brick or block producing county in 1915, with Beaver County second and McKean third. Front brick is made chiefly in Armstrong County. Seventy-five million nine hundred and eighteen thousand brick, valued at $842,385, or nearly one-third of the production and value for the State being reported for 1915 from that county, a decrease of 2,314,000 brick and $33,412 from 1914. Clearfield County is the largest producer of clay fire brick, and reported 103,299,000 9-inch equivalent brick, valued at $1,997,938 or more than one-fourth of the production and value of the State, an increase of 21,877,000 brick and $409,979 over 1914. Huntington County is the largest producer of silica fire brick, and reported 52,245,000 9-inch equivalent brick, valued at $1,104,088, or considerably over one-half of the production and value of the State, a decrease of 1,240,000 brick and $96,483 from 1914.

Clearfield County, which was second in 1914, ranked first in 1915, with products valued at $2,472,299, an increase of $414,198. Fire brick is Clearfield's principal clay product, but vitrified brick and front brick are also made there in considerable quantities. Philadelphia County, which was third in 1914, was second in 1915, with products valued at $2,052,099, a slight decrease—$821. Philadelphia's principal clay product is common brick, though terra cotta and fire brick are also important products there. Allegheny County, which was first in 1914, was third in 1915, with products valued at $2,006,000, a decrease of $322,483. Allegheny's principal product is fire brick; it is also a large producer of common brick.

TENNESSEE.

The total value of Tennessee's clay products in 1915 was $1,548,220—brick and tile, $1,441,831; pottery, $106,389—an increase of $1,905. The principal product was common brick, of which 113,004,000 brick were reported for 1915, valued at $655,094, a decrease of 24,402,000 brick and of $188,269. The value of common brick constituted 42 per cent of the value of all clay products of the State in 1915. Vitrified brick or block was second in importance in 1915, and sewer pipe was third. Tennessee's principal pottery product is turpentine cups made in Hamilton County.

Sullivan County was the largest producer of common brick in 1915, reporting 26,836,000 brick, valued at $158,529, with Shelby County second and Davidson third.

Tennessee ranked nineteenth in the value of clay products in 1915, and 69 operators reported sales for that year.

Hamilton County was the principal clay-working county of the State, its production in 1915 being valued at $617,090, or 40 per cent of the State's total, an increase of $162,316, and Scott County was second. Hamilton County's chief clay products in 1915 were sewer pipe and turpentine cups, and Scott's chief product was vitrified brick.

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TEXAS.

The value of the clay products of Texas in 1915 was $1,976,890—brick and tile, $1,911,501; pottery, $65,389—a decrease of $304,097. Texas ranked fourteenth in the value of clay products in 1915, and 93 operators reported sales during that year. In 1915 Texas was eighth in value of front brick and ninth in sewer pipe and fireproofing. Common brick is its principal clay product, 147,469,000 brick, valued at $828,386, being reported for 1915, a decrease of 35,226,000 brick and of $352,200. The value of common brick constituted 42 per cent of the value of all clay products of the State in 1915. Sewer pipe ranked second, front brick third, and fireproofing fourth.

Ellis County was the largest producer of common brick for 1915, reporting 46,621,000 brick, valued at $227,655, a decrease of 12,974,000 brick and of $150,059. Sewer pipe was reported from Wilson and Bowie counties, but the figures are not disclosed. Wilson County is the leading clay-working county in the State; its principal product is sewer pipe.

VIRGINIA.

The total value of Virginia's brick and tile products in 1915 was $1,447,802, a decrease of $24,546. Virginia ranked twenty-second in value of clay products in 1915 and had 58 operators reporting sales. Virginia was eighth in value of common brick, the chief clay product, of which 186,649,000 brick, valued at $1,215,559, were reported for 1915, a small decrease. The value of common brick constituted 84 per cent of the State's clay products in 1915. Front brick is the only other clay product of importance in Virginia. In 1915 it was valued at $192,443, a decrease of $20,094.

Henrico was the leading county in the production and value of common brick, reporting 39,144,000 brick, valued at $256,256, a decrease of 1,156,000 brick and of $29,419. The average price per thousand in this county decreased 54 cents to $6.55. Alexandria County was second, reporting 34,610,000 brick, valued at $230,238, an increase of 10,915,000 brick and of $85,634. The average price per thousand increased in this county 55 cents to $6.65. These two counties are the principal sources of supply of common brick for Richmond, Va., and Washington, D. C., respectively. Front brick was made most largely in Alexandria County.

Virginia's only pottery product in 1915 was tobacco pipes, made in Appomattox County.

Alexandria County was the leading clay-working county in the State in 1915, reporting wares valued at $415,683, an increase of $71,827.

WASHINGTON.

The value of Washington's brick and tile products in 1915 was $1,454,436, a decrease of $355,055. Washington ranked seventh in value of terra cotta and fireproofing. Washington's principal clay product in 1915 was sewer pipe, valued at $318,397, a decrease of $144,501. Common brick was the second product in value and there were 43,279,000 brick reported, valued at $285,423, a decrease of 8,378,000 brick and of $66,142; vitrified brick was third, and terra cotta fourth. Washington ranked twenty-first in value of clay products in 1915, and 43 operators reported sales for that year.

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King County, with Seattle and Tacoma for markets, is the principal producer of common brick and reported 18,622,000 brick in 1915, or 43 per cent of the State's total, valued at $109,649, or 38 per cent of the total, a decrease of 7,056,000 brick and of $55,061. King was the leading county in the production of drain tile, sewer pipe, and terra cotta, and was also the leading clay-working county reporting wares, valued at $825,865, or 57 per cent of the State's total, a decrease of $265,660. Spokane County, whose principal product was sewer pipe, was second with wares valued at $240,106.

WEST VIRGINIA.

The total value of West Virginia's clay products in 1915 was $6,284,527—brick and tile, $1,773,904; pottery, $4,510,623—an increase of $523,116. This increase was in the pottery industry; the brick and tile products showed a slight decrease. West Virginia ranked eighth in value of clay products in 1915, fifteenth in brick and tile, and third in pottery products. It was second in value of white ware and sanitary ware, fourth in vitrified brick or block, and in china and porcelain electrical supplies, and sixth in tile, not drain. West Virginia's principal clay product is white ware, valued at $2,837,766, or 45 per cent of the State's total, an increase of $260,000. Second in importance was sanitary ware, valued at $1,056,585, an increase of $183,598. Vitrified brick or block was the third, being valued at $841,067, a decrease of $58,148. Common brick was fourth, being valued at $445,843, a small decrease.

Hancock County was the leading producer of vitrified brick or block and reported 51,280,000 brick or block, valued at $622,476, or 74 per cent of the value for the State. This was a decrease of 2,449,000 brick and of $101,081.

Hancock is the leading clay-working county of the State, its production in 1915 being valued at $3,261,539, or more than half of the State's total, and a decrease of $13,962. The decrease was in the brick and tile industry, as pottery products in this county increased $112,363. Of this production $2,499,710 was pottery, principally white ware, and $761,829 was brick and tile, principally vitrified brick or block. West Virginia ranked third in the value of pottery produced in 1915.

WISCONSIN.

The total value of Wisconsin's clay products in 1915 was $910,558—brick and tile, $902,199; pottery $8,359—a decrease of $40,441. Wisconsin's principal product is common brick, of which there were 107,268,000 brick reported, valued at $735,028, a small decrease in both quantity and value. The value of common brick constituted 81 per cent of the value of Wisconsin's clay products in 1915. Wisconsin was the twenty-seventh State in the value of clay products in 1915, and 75 operators reported sales for that year.

Milwaukee was the leading clay-working county, with products in 1915 valued at $238,513, nearly all of which was common brick. This county reported 32,661,000 common brick, valued at $227,954 in 1915, a decrease of 9,267,000 brick and of $60,980.

Dunn County, whose principal product also was common brick was second, with products valued at $226,403.

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CLAY.

GENERAL CONDITIONS.

Clay available for the manufacture of clay products is one of the most widely distributed minerals. Hence there are clay-working plants scattered over every State and Territory in the Union. Miners of the lower-grade clays are usually also the manufacturers, but as the higher grades of ware are reached, the rule is that fewer and fewer manufacturers are also miners, until in the highest grades of ware the rule is that the manufacturer buys and does not mine the clays he uses. The figures given in the following tables represent clay that is mined and not manufactured by the miner, but is sold as clay. The clay thus sold is small in quantity compared with the total production and includes mainly clay used for high-grade pottery and tile, for paper making, and for refractory products.

The condition of the clay-mining industry in 1915, on the whole, showed progress, the marketed production and value showing considerable increase over 1914. In the clay-mining industry as in the clay-working industries, business in the latter portion of the year was generally reported to have been much better than in the earlier months, with bright prospects for a large output in 1916. With the prospects of a continued decrease in the imports of clays used in the higher grades of ware it would seem that the users of these high-grade clays must turn to the domestic source of supply, and 1916 should show a large increase in their production. The conditions in Europe, from which in normal times this country has received its principal supplies of clays used in the higher grades of pottery, glass-house pots, crucibles, and lead pencils, have been such as to cut off these supplies. This shortage was not felt so keenly during the first year of the war, but later the Survey was called on to assist in obtaining these clays to supply the approaching exhaustion. Clays suitable for such uses have been reported from Arkansas, Delaware, Illinois, Missouri, and Ohio, and information concerning them has been disseminated in response to many inquiries.

The most essential requirements of clay for these uses, as outlined by the inquirers, are that for crucibles it shall be very plastic, not softening materially at 2,600° or 2,700° F., and that it shall not split or blow at high temperatures; for lead pencils that it shall be very plastic, with strong binding qualities, and shall be very smooth in the finished product. The Bureau of Standards, Department of Commerce, has made a laboratory study of the properties of some foreign plastic fire clays, comparing them with similar American clays, and has found [1] that a mixture of American clays will produce the same or better results than those obtained with the European clays.

The imports of clay, which showed a large increase in 1914, decreased in 1915 and were the smallest in both quantity and value since 1908.

PRODUCTION.

The total quantity of clay sold as such in 1915 was 2,362,954 short tons, an increase of 153,094 tons, or 7 per cent. This clay was valued at $3,971,941, or $1.68 per ton, an increase of $215,373, or 6 per cent, but a decline of 2 cents in the average price. Three kinds of clay, ball clay, fire clay, and stoneware clay, and "miscellaneous" in-

[1] U. S. Bur. Standards Tech. Paper 79, 1916.

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creased in production in 1915. Fire clay made the largest gain in production, 161,014 tons; ball clay increased 7,421 tons; stoneware clay, 3,914 tons; and miscellaneous, 87,977 tons. These clays also showed increase in value, and in addition to them, slip clay, which decreased slightly in production, made a small gain in value of clay marketed. Fire clay showed the largest increase in value, $214,205; ball clay increased $46,143; stoneware clay, $9,819; and miscellaneous clay, $74,161. Four varieties of clay decreased in production and three decreased in value. Brick clay showed the largest decrease in quantity, 97,186 tons, and kaolin decreased 6,160 tons, paper clay 3,295 tons, and slip clay 591 tons. Brick clay also showed the largest decrease in value, $67,989; kaolin decreased $43,297, and paper clay $18,712. Fire clay is the chief kind, judged by production and value, and constituted 66 per cent of the quantity and 59 per cent of the value of clay marketed in 1915. Paper clay ranked second in value of output, and ball clay third. The average price per ton varied but little in 1915 compared with 1914. The greatest changes were in slip clay, which advanced 31 cents; kaolin, 29 cents; and ball clay, 24 cents.

Clay marketed in the United States, 1905–1915.

Year.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1905	44,675	$326,835	76,339	$307,238	24,565	$33,384	61,345	$167,212	1,229,647	$1,529,468
1906	51,937	369,452	75,963	342,708	21,427	31,546	54,173	199,073	1,380,472	1,878,011
1907	47,645	340,311	66,191	293,943	20,325	37,925	52,413	195,515	1,474,462	2,054,698
1908	28,649	216,243	64,510	310,943	10,087	22,370	40,838	133,770	1,101,579	1,496,139
1909	31,227	241,060	81,586	386,764	18,010	30,527	49,074	214,194	1,463,919	2,082,193
1910	34,221	255,873	85,949	420,476	17,696	29,962	70,637	257,265	1,638,931	2,157,720
1911	27,400	221,045	99,265	454,435	8,393	16,770	65,072	220,710	1,526,921	2,112,827
1912	25,852	220,747	119,857	522,924	16,339	27,573	64,939	227,545	1,695,337	2,363,357
1913	28,834	235,457	126,377	567,977	10,902	24,505	67,134	237,672	1,820,379	2,592,591
1914	34,191	284,817	116,328	558,334	8,237	17,731	67,927	255,767	1,409,467	2,147,277
1915	28,031	241,520	113,033	539,622	7,646	18,774	75,348	301,910	1,570,481	2,361,482

Year..	Stoneware clay.		Brick clay.[a]		Miscellaneous clay.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1905	181,485	$219,767	.....	.....	188,077	$184,102	1,806,133	$2,768,006
1906	146,861	150,774	.....	.....	296,619	273,092	2,027,452	3,245,256
1907	125,060	136,576	136,515	$112,003	261,068	277,577	2,183,679	3,448,548
1908	124,192	102,390	210,556	154,575	143,490	173,556	1,723,901	2,599,986
1909	130,757	137,264	222,686	171,183	162,388	186,522	2,159,647	3,449,707
1910	152,942	153,044	178,625	128,039	215,228	223,106	2,389,229	3,625,485
1911	151,384	165,751	142,020	123,900	162,243	165,325	2,182,698	3,480,763
1912	124,409	115,522	229,306	204,504	254,226	263,848	2,530,265	3,946,020
1913	153,353	143,587	158,890	137,976	282,120	240,094	2,647,989	4,180,459
1914	130,383	116,610	199,154	161,852	244,173	214,180	2,209,860	3,756,568
1915	134,297	126,429	101,968	93,863	332,150	288,341	2,362,954	3,971,941

[a] Included in "Miscellaneous" in 1905 and 1906.

The maximum, both in quantity and value, of clay marketed in the period covered by this table was attained in 1913, and the value of the output of 1915 was exceeded only in that year. The quantity of clay sold in 1915 was exceeded by only three years, namely, 1910, 1912, and 1913. Kaolin reached its maximum production and value in 1906, its minimum production in 1912, and its minimum value in 1908. Ball clay reached its maximum quantity and value in 1915. Paper clay and fire clay reached their maximum quantity and value in 1913.

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Clay marketed in the United States in 1914.

State.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.		Stoneware clay.		Brick clay.		Miscellaneous clay.[a]		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama									27,973	$34,607							27,973	$34,607
Arkansas									(b)	(b)							(b)	(b)
California	(b)	(b)					(b)	(b)	56,391	66,732	21,070	$18,541	28,609	$35,223	133	$2,131	106,543	139,727
Colorado									15,832	35,791			41,217	26,111	100	250	57,149	64,152
Connecticut													(b)	(b)			(b)	(b)
Delaware	7,819	$66,282							(b)	(b)							10,371	71,386
Florida							(b)	(b)									(b)	(b)
Georgia			62,298	$267,011					11,461	7,116	(b)	(b)	(b)	(b)	71,795	15,795	146,374	290,514
Illinois									125,071	138,876	26,012	19,842	(b)	(b)	(b)	(b)	161,084	168,354
Indiana									31,849	29,344	(b)	(b)	(b)	(b)	2,300	4,600	36,055	37,644
Iowa									(b)	(b)					10,500	4,000	10,750	4,250
Kentucky					(b)	(b)	(b)	(b)	54,771	57,946	(b)	(b)			59	250	66,229	91,837
Maryland	(b)	(b)	(c)	(c)					14,288	25,194	(b)	(b)	8,967	11,304	c1,400	c1,450	29,755	43,498
Massachusetts									(b)	(b)			481	542			1,131	2,742
Michigan					1,463	$4,572											1,463	4,572
Minnesota															(b)	(b)	(b)	(b)
Mississippi											(b)	(b)					(b)	(b)
Missouri	313	2,217							203,755	432,786	3,199	3,899			(b)	(b)	209,181	463,703
Montana									2,757	9,205					221	443	2,978	9,648
Nebraska									(b)	(b)	(b)	(b)			(b)	(b)	(b)	(b)
New Jersey					(b)	(b)	2,596	$13,341	273,973	485,599	11,455	25,532	22,295	24,229	63,373	99,870	373,708	648,584
New Mexico									1,310	2,637					732	2,058	2,042	4,695
New York					(b)	(b)			(b)	(b)					2,689	1,640	5,640	7,286
North Carolina	17,168	164,534									(b)	(b)			600	300	17,773	164,837
North Dakota									(b)	(b)							(b)	(b)
Ohio					3,095	4,763			171,705	162,944	59,577	37,781	53,714	26,716	36,242	15,152	324,333	247,356
Oregon									(b)	(b)	(b)	(b)					(b)	(b)
Pennsylvania			26,124	161,451					306,183	519,505	(b)	(b)	28,152	22,366	14,615	9,810	376,697	715,458
South Carolina			27,906	129,872					(b)	(b)							28,421	133,047
Tennessee							30,460	87,332	31,377	41,461	(b)	(b)			274	433	62,861	129,976
Texas									1,460	8,594	(b)	(b)			30	150	2,362	9,616
Utah									5,837	13,961							5,837	13,961
Vermont	4,941	33,584							(b)	(b)							4,976	33,701
Virginia									(b)	(b)					1,200	120	2,177	2,722
Washington					(b)	(b)			342	3,139							601	3,329
West Virginia									67,265	53,545							67,265	53,545

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Wisconsin	.....	.....	.....	.....	.....	.....	.....	.....	(b)	(b)	.....	.....	(b)	(b)	160	200	646	1,149
Wyoming	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(b)	(b)	(b)	(b)
Other States [d]	3,950	18,200	.....	.....	3,679	8,396	34,871	155,094	5,867	18,295	10,060	11,025	15,609	13,261	37,750	55,528	[e] 62,350	[e] 159,872
	34,191	284,817	116,328	558,334	8,237	17,731	67,927	255,767	1,409,467	2,147,277	130,383	116,610	199,154	161,852	244,173	214,180	2,209,960	3,756,568
Average price per ton	.....	8.33	.....	4.80	.....	2.15	.....	3.77	.....	1.52	.....	0.89	.....	0.81	.....	0.88	.....	1.70

[a] Including bentonite, modeling clay, pipe clay, terra-cotta clay, and clay for medicinal use.
[b] Included in "Other States."
[c] Paper clay, for Maryland, is included in "Maryland Miscellaneous."
[d] Includes all products made by less than 3 producers in 1 State.
[e] Made up of State totals of Arkansas, Connecticut, Florida, Minnesota, Mississippi, Nebraska, North Dakota, Oregon, and Wyoming.

Clay marketed in the United States in 1915.

State.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.		Stoneware clay.		Brick clay.		Miscellaneous clay.[a]		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Alabama	.....	.....	.....	.....	.....	.....	.....	.....	31,520	$34,882	.....	.....	.....	.....	(b)	(b)	31,870	$35,232
Arkansas	.....	.....	.....	.....	.....	.....	.....	.....	(b)	(b)	.....	.....	.....	.....	.....	.....	(b)	(b)
California	(b)	(b)	.....	.....	.....	.....	(b)	(b)	52,817	69,885	8,900	$8,475	18,170	$17,423	13,625	$14,528	94,508	118,130
Colorado	.....	.....	.....	.....	.....	.....	.....	.....	20,011	40,234	.....	.....	49,739	26,282	1,363	1,664	71,113	68,180
Connecticut	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(b)	(b)	.....	.....	(b)	(b)
Delaware	6,247	$53,751	.....	.....	.....	.....	.....	.....	(b)	(b)	.....	.....	.....	.....	118	472	10,148	61,789
Florida	.....	.....	.....	.....	.....	.....	(b)	(b)	.....	.....	.....	.....	.....	.....	.....	.....	(b)	(b)
Georgia	.....	.....	67,752	$292,943	.....	.....	.....	.....	12,033	7,577	1,325	1,325	.....	.....	85,140	17,620	166,250	319,465
Idaho	.....	.....	.....	.....	.....	.....	.....	.....	(b)	(b)	.....	.....	.....	.....	.....	.....	(b)	(b)
Illinois	.....	.....	.....	.....	.....	.....	.....	.....	93,888	120,008	32,295	26,165	(b)	(b)	37,421	22,847	163,904	169,320
Indiana	.....	.....	.....	.....	.....	.....	.....	.....	45,766	36,969	4,056	3,298	(b)	(b)	2,080	4,600	52,015	45,030
Iowa	.....	.....	.....	.....	.....	.....	.....	.....	119	244	.....	.....	.....	.....	11,460	5,229	11,579	5,473
Kentucky	.....	.....	.....	.....	.....	.....	13,677	$45,199	62,998	72,479	(b)	(b)	(b)	(b)	596	691	80,684	121,676
Louisiana	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(b)	(b)	(b)	(b)
Maryland	.....	.....	.....	.....	.....	.....	.....	.....	15,976	31,453	(b)	(b)	(b)	(b)	500	500	17,157	32,966
Massachusetts	.....	.....	.....	.....	.....	.....	.....	.....	(b)	(b)	.....	.....	459	593	.....	.....	699	1,313
Michigan	.....	.....	.....	.....	1,198	$3,805	.....	.....	.....	.....	.....	.....	(b)	(b)	.....	.....	3,142	5,605
Minnesota	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(b)	(b)	(b)	(b)
Mississippi	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(b)	(b)	.....	.....	.....	.....	(b)	(b)
Missouri	(b)	(b)	.....	.....	.....	.....	.....	.....	303,432	604,777	(b)	(b)	.....	.....	(b)	(b)	308,385	641,040

[a] Including bentonite, modeling clay, sewer-pipe clay, terra-cotta clay, and clay for medicinal use.
[b] Included in "Other States."

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Clay marketed in the United States in 1915—Continued.

State.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.		Stoneware clay.		Brick clay.		Miscellaneous clay.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Montana	.....	.....	.....	.....	.....	.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)	.....	.....	3,670	$17,842
Nebraska	.....	.....	.....	.....	.....	.....	.....	.....	(a)	(a)	(a)	(a)	.....	.....	(a)	(a)	(a)	(a)
New Jersey	.....	.....	.....	.....	(a)	(a)	8,639	$27,879	227,813	$412,353	12,871	$28,706	19,886	$35,808	71,784	$113,132	340,726	617,904
New Mexico	.....	.....	.....	.....	.....	.....	.....	.....	2,507	7,077	.....	.....	.....	.....	61	243	2,568	7,320
New York	.....	.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)	.....	.....	(a)	(a)	1,520	1,170	7,261	15,913
North Carolina	15,699	$143,505	.....	.....	.....	.....	.....	.....	.....	.....	165	83	.....	.....	205	108	16,069	143,696
North Dakota	.....	.....	.....	.....	.....	.....	.....	.....	(a)	(a)	.....	.....	.....	.....	.....	.....	(a)	(a)
Ohio	.....	.....	.....	.....	(a)	(a)	.....	.....	187,096	184,325	65,249	47,936	(a)	(a)	30,370	12,262	285,590	247,413
Oregon	.....	.....	.....	.....	.....	.....	.....	.....	(a)	(a)	(a)	(a)	.....	.....	.....	.....	(a)	(a)
Pennsylvania	.....	.....	20,593	$128,291	.....	.....	.....	.....	377,090	567,913	(a)	(a)	7,627	7,717	33,507	27,309	441,918	735,321
South Carolina	.....	.....	24,688	118,388	.....	.....	.....	.....	(a)	(a)	.....	.....	.....	.....	.....	.....	24,854	119,218
Tennessee	.....	.....	.....	.....	.....	.....	27,257	78,497	32,628	44,500	(a)	(a)	.....	.....	.....	.....	59,975	123,132
Texas	.....	.....	.....	.....	.....	.....	.....	.....	2,459	9,663	(a)	(a)	.....	.....	31	153	3,204	10,610
Utah	(a)	(a)	.....	.....	.....	.....	.....	.....	5,273	8,538	.....	.....	.....	.....	.....	.....	5,398	8,807
Vermont	5,114	36,670	.....	.....	.....	.....	.....	.....	(a)	(a)	.....	.....	.....	.....	205	205	5,388	37,081
Virginia	(a)	(a)	.....	.....	.....	.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)	3,240	324	4,958	4,333
Washington	.....	.....	(b)	(b)	(a)	(a)	.....	.....	502	3,364	.....	.....	.....	.....	(a)	(a)	829	4,340
West Virginia	.....	.....	.....	.....	.....	.....	.....	.....	85,103	59,610	.....	.....	.....	.....	.....	.....	85,103	59,610
Wisconsin	.....	.....	.....	.....	.....	.....	.....	.....	(a)	(a)	.....	.....	(a)	(a)	(a)	(a)	310	413
Wyoming	.....	.....	.....	.....	.....	.....	.....	.....	(a)	(a)	.....	.....	.....	.....	(a)	(a)	(a)	(a)
Other States c	971	7,594	.....	.....	6,448	$14,969	26,045	150,335	11,450	45,631	9,436	10,441	6,087	6,040	38,974	65,284	d 63,580	d 193,769
	28,031	241,520	113,033	539,622	7,646	18,774	75,348	301,910	1,570,481	2,361,482	134,297	126,429	101,968	93,863	332,150	288,341	2,362,954	3,971,941
Average price per ton	.....	8.62	.....	4.77	.....	2.46	.....	4.01	.....	1.50	.....	.94	.....	.92	.....	.87	.....	1.68

a Included in "Other States."
b Paper clay, for Washington, is included in "Washington miscellaneous."
c Includes all products made by less than 3 producers in 1 State.
d Made up of State totals of Arkansas, Connecticut, Florida, Idaho, Louisiana, Minnesota, Mississippi, Nebraska, North Dakota, Oregon, and Wyoming.

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Forty States reported sales of clay in 1915, an increase of two, Idaho and Louisiana. The leading clay-producing State, as for many years, in both quantity marketed and value of output, was Pennsylvania. The quantity of clay sold as clay in this State in 1915 increased 65,221 tons and its value increased $19,863. Pennsylvania reported nearly one-fifth of the quantity and value of the clay marketed in 1915. Fire clay is the most important clay mined in Pennsylvania, and in 1915 it constituted 85 per cent of the output and 77 per cent of the value of clay marketed in that State. New Jersey ranked second in production, but third in value of clay marketed in 1915, reporting 14 per cent of the total output and nearly 16 per cent of its value, a decrease of 32,977 tons and of $30,680, compared with 1914. In this State also fire clay is the leading kind, 67 per cent of the output and value of the clay mined there being of that variety. Missouri was third in output, but second in value, with 13 per cent of the output and 16 per cent of the value. There was an increase of 99,204 tons in quantity and $177,337 in value, compared with 1914. Here, again, fire clay is the most important kind and constituted 98 per cent of the State's output and 94 per cent of its value in 1915, an increase of 99,677 tons, or 49 per cent, in quantity and $171,991, or 40 per cent, in value. Ohio, the leading clay-working State, was fourth in quantity and fifth in value of clay marketed in 1915, with a decrease in production but an increase in value. Georgia was fifth in quantity and fourth in value, and Illinois was sixth in quantity and value. These six States—Pennsylvania, New Jersey, Missouri, Ohio, Georgia, and Illinois—reported 1,706,773 tons, or 72 per cent of the total quantity, and $2,730,463, or 69 per cent of the total value, in 1915.

In 1915 Pennsylvania was the leading State in production, but second in value of fire clay, and reported 24 per cent of the total quantity and value, an increase of 70,907 tons and of $48,408. Missouri was second in quantity and first in value, and reported 19 per cent of the total quantity and 26 per cent of the value of fire clay in 1915. New Jersey was third in both quantity and value, and reported 15 per cent of the quantity and 17 per cent of the value, a decrease of 46,160 tons and of $73,246. New Jersey was the only one of the leading States to show decrease in value of clay marketed in 1915. Ohio was fourth, and Illinois fifth, as in 1914. The average price per ton of fire clay in these States in 1915 was: Illinois, $1.28; Missouri, $1.99; New Jersey, $1.81; Ohio, $0.99; and Pennsylvania, $1.51. In 1914 the corresponding prices of fire clay were: Illinois, $1.11; Missouri, $2.12; New Jersey, $1.77; Ohio, $0. 95; and Pennsylvania, $1.70.

Kaolin, the purest form of clay and in some respects the most valuable, was reported from seven States, an increase of one—Maryland reporting none for 1915, and Utah and Virginia entering the list of kaolin producers. North Carolina is the leading State and reported more than half of the output and value for 1915. Paper clay was produced most largely in Georgia, although Pennsylvania and South Carolina are also large producers. Tennessee was the largest producer of ball clay.

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IMPORTS.

The following table shows the imports of clay from 1901 to 1915. As the most important imported clays, kaolin and "common blue," which is really high-grade fire clay, come from Europe, the imports of these clays would be expected to fall off.

Clay imported into the United States for consumption, 1901–1915.

Year.	Kaolin or china clay.			All other clays.						Total.	
				Unwrought.		Wrought.		Common blue.			
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1901	131,887	$742,984	$5.63	30,909	$175,659	6,392	$84,807	6,872	$82,700	176,060	$1,086,150
1902	149,029	883,092	5.93	28,931	138,032	3,002	47,093	7,815	86,588	188,777	1,154,805
1903	157,088	898,573	5.72	32,691	152,018	2,725	36,211	10,165	110,794	202,669	[a]1,198,418
1904	160,046	891,708	5.57	25,402	123,241	1,363	25,026	5,263	50,364	192,074	1,090,339
1905	187,803	1,019,650	5.43	30,661	151,583	1,560	38,036	5,909	54,390	225,933	1,263,659
1906	223,404	1,208,189	5.41	33,267	166,366	1,889	37,549	9,220	84,578	267,780	1,496,682
1907	239,923	1,582,893	6.60	31,196	145,698	2,520	81,155	12,378	110,686	286,017	1,920,432
1908	176,895	1,129,847	6.39	27,730	129,411	1,372	22,990	4,872	37,053	219,869	1,319,301
1909	246,381	1,505,779	6.11	30,147	134,978	1,906	50,632	12,346	104,401	290,780	1,795,790
1910	257,902	1,593,472	6.18	27,890	113,352	1,496	26,205	21,176	181,334	308,464	1,914,363
1911	255,107	1,461,068	5.73	26,086	100,540	1,032	10,436	17,193	124,278	299,418	1,696,322
1912	278,276	1,629,105	5.85	32,473	127,004	794	12,109	23,112	184,018	334,655	1,952,236
1913	268,666	1,623,993	6.04	42,582	155,693	1,889	22,178	24,986	204,911	338,123	2,006,775
1914	328,038	1,927,425	5.88	50,069	195,956	3,232	41,712	16,761	122,325	398,100	2,287,418
1915	209,132	1,152,778	5.51	23,718	90,367	1,343	12,433	8,864	62,569	243,057	1,318,147

[a] Includes clay not otherwise provided for, valued at $822, but for which no quantity is reported.

The imports of clay, except kaolin or china clay, and the clay designated as "common blue," are unimportant. Imports of every variety of clay decreased in both quantity and value in 1915, compared with 1914. The total quantity decreased 155,043 tons, or 39 per cent, and the value decreased $969,271, or 42 per cent. Kaolin showed the largest decrease—118,906 tons and $774,647. "Common blue" clay also showed a considerable decrease. The imports of clay in 1915 were the smallest in quantity since 1908 and in value since 1905. The imports of kaolin were also the smallest in quantity and value since 1908.

Kaolin is the most important of the clays imported, 86 per cent of the quantity of imports and 87 per cent of their value were of this variety.

BUILDING OPERATIONS.

The following tables show the building operations of some of the leading cities of the country in 1915. Efforts were made to obtain detailed information from 157 cities. For 123 cities sufficient detail was received to include them in a table showing classes of buildings; for 21 cities only the totals for permits or buildings and cost of buildings could be obtained; and for 13 cities no data were obtained.

The first table shows a comparison between 1914 and 1915 in 48 cities. The figures here given seem to show that, on the whole, the building industry was in a more prosperous condition in 1915 than in 1914, though 9 cities that showed increase in 1914 showed decrease in

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1915. The most noteworthy features of the building industry in 1915 were the general increase, the large increase ($28,993,559) in the cost of operations in New York City, by which it regained its rank as the leading city of the country, which it lost in 1914, and the decrease in the number of permits or buildings, which indicates the more costly character of the operations carried on during the year.

Twenty-eight of the cities given in the first table showed increase and 20 showed decrease in the cost of building operations in 1915. Twenty-one cities that showed decrease in 1914 rallied and showed increase in 1915, and 7 cities showed increase in both years, the net increase being $22,016,845, or nearly 4 per cent. Sixteen cities showed increase in 1914 and 32 showed decrease, the net increase being $53,468,271, or nearly 8 per cent.

Various causes are assigned for these changes. Many cities ascribe the decrease in the cost of building operations in 1915 to the erection of an unusually large number of costly buildings in 1914, and a few to financial stringency. The increase is ascribed to generally improved conditions, especially during the latter portion of the year, and to good crops.

New York showed the largest increase and Chicago the next largest. The city to show the largest proportionate increase was Cincinnati—nearly 65 per cent. San Francisco, which in 1914 showed the largest increase, showed the largest decrease in 1915, the natural reaction to be expected after an international exposition.

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Building operations in the leading cities of the United States in 1914 and 1915.

City.	1914		1915		Increase or decrease in 1915.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Cost.	Per cent.
Atlanta, Ga.	3,146	$4,564,387	2,752	$4,589,214	+ $24,827	+ 0.54
Baltimore, Md.	12,058	16,308,299	1,957	9,541,891	− 6,766,408	−41.49
Boston, Mass.	4,247	23,187,282	6,328	29,113,692	+ 5,926,410	+25.56
Brooklyn, N. Y.	11,445	41,872,307	14,515	45 601,851	+ 3,729,544	+ 8.91
Buffalo, N. Y.	3,984	10,709,000	4,809	11,798,000	+ 1,089,000	+10.17
Cambridge, Mass.	541	6,300,105	627	3,384,290	− 2,915,815	−46.28
Chicago, Ill.	9,938	83,261,710	10,340	97,291,400	+14,029,690	+16.85
Cincinnati, Ohio.	3,600	8,150,000	4,797	13,443,414	+ 5,293,414	+64.95
Cleveland, Ohio.	12,790	26,991,050	14,451	32,660,305	+ 5,669,255	+21.00
Columbus, Ohio.	2,636	6,885,065	2,836	4,928,425	− 1,956,640	−28.42
Dayton, Ohio.	870	2,977,990	1,234	3,534,620	+ 556,630	+18.69
Denver, Colo.	3,721	3,750,460	3,085	2,648,575	− 1,101,885	−29.38
Detroit, Mich.	7,844	28,207,395	8,966	32,235,540	+ 4,028,145	+14.28
Fall River, Mass.	590	1,493,235	704	1,824,696	+ 331,461	+22.20
Grand Rapids, Mich.	1,982	3,618,119	1,909	2,684,037	− 934,082	−25.82
Hartford, Conn.	1,025	4,052,076	1,403	5,575,895	+ 1,523,819	+37.61
Indianapolis, Ind.	5,693	7,933,381	6,177	7,083,642	− 849,739	−10.71
Jersey City, N. J.	1,171	3,826,174	1,306	5,351,630	+ 1,525,456	+39.87
Kansas City, Kans.	737	1,110,988	748	962,749	− 148,239	−13.34
Kansas City, Mo.	3,253	10,204,970	3,517	10,667,405	+ 462,435	+ 4.53
Los Angeles, Cal.	9,979	17,361,925	7,845	11,888,662	− 5,473,263	−31.52
Louisville, Ky.	2,306	4,397,310	2,432	4,055,390	− 341,920	− 7.78
Lowell, Mass.	633	773,514	732	1,231,310	+ 457,796	+59.18
Memphis, Tenn.	2,617	2,946,818	2,303	2,730,488	− 216,330	− 7.34
Milwaukee, Wis.	3,865	9,882,085	3,882	11,564,325	+ 1,682,240	+17.02
Minneapolis, Minn.	6,015	15,214,525	6,831	16,349,940	+ 1,135,415	+ 7.46
Newark, N. J.	2,105	10,061,910	1,218	6,162,052	− 3,899,858	−38.76
New Bedford, Mass.	1,062	3,039,736	1,012	3,126,734	+ 86,998	+ 2.86
New Haven, Conn.	1,136	4,380,842	1,524	7,104,947	+ 2,724,105	+62.18
New Orleans, La.	1,635	2,948,751	1,334	2,950,357	+ 1,606	+ .05
New York, N. Y.	8,764	74,030,241	7,714	103,023,800	+28,993,559	+39.16
Oakland, Cal.	3,649	4,717,520	3,352	5,045,290	+ 327,770	+ 6.95
Omaha, Nebr.	1 295	4,610,456	1,351	5,385,005	+ 774,549	+16.80
Philadelphia, Pa.	12,774	34,694,340	13,884	35,010,640	+ 316,300	+ .91
Pittsburgh, Pa.	3,522	18,194,182	3,916	14,227,020	− 3,967,162	−21.80
Portland, Oreg.	5,959	8,334,075	4,623	4,895,345	− 3,438,730	−41.26
Providence, R. I.	3,589	6,334,900	3,848	7,023,700	+ 688,800	+10.87
Richmond, Va.	1,591	3,391,571	1,710	3,244,752	− 146,819	− 4.33
Rochester, N. Y.	3,247	8,733,257	3,391	9,108,333	+ 375,076	+ 4.29
St. Joseph, Mo.	740	625,574	469	942,770	+ 317,196	+50.70
St. Louis, Mo.	9,418	12,885,398	9,052	11,439,320	− 1,446,078	−11.22
St. Paul, Minn.	3,741	14,718,696	2,688	9,237,458	− 5,481,238	−37.24
San Francisco, Cal.	5,907	28,177,563	6,461	13,990,704	−14,186,859	−50.35
Scranton, Pa.	665	1,668,904	784	1,683,592	+ 14,688	+ .88
Seattle, Wash.	9,104	12,664,970	8,217	6,456,995	− 6,207,975	−49.02
Syracuse, N. Y.	1,855	3,412,184	1,934	4,693,316	+ 1,281,132	+37.55
Washington, D. C.	3,701	10,415,645	4,428	9,749,301	− 666,344	− 6.40
Worcester, Mass.	1,587	5,731,469	1,794	4,526,382	− 1,205,087	−21.03
	203,732	619,752,354	201,190	641,769,199	+22,016,845	+ 3.55

The total number of permits or buildings in these 48 cities decreased 2,542 in 1915. They ranged from 469 permits or buildings in St. Joseph to 14,515 in Brooklyn. The average cost per operation in these 48 cities was $3,190 in 1915 and $3,042 in 1914. In New York the average cost was $13,355 in 1915 and $8,447 in 1914; in Chicago it was $9,409 in 1915 and $8,378 in 1914; in Brooklyn, the third city in the cost of building operations, it was $3,142 in 1915 and $3,659 in 1914; in Philadelphia, the fourth city, it was $2,522 in 1915 and $2,716 in 1914; and in Cleveland, the fifth city, it was $2,260 in 1915 and $2,110 in 1914.

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City.	Wooden buildings.								Fire-resisting buildings.	
	New.		Additions, alterations, and repairs.		Miscellaneous.		Total.		Brick or hollow tile, new.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Akron, Ohio	1,624	$2,410,940	500	$177,470	.....	.....	2,124	$2,588,410	296	$3,185,715
Albany, N. Y	373	1,833,835	77	98,745	.....	.....	450	1,932,580	191	1,458,445
Allentown, Pa	65	32,085	30	10,485	5	$800	100	43,370	470	1,201,450
Altoona, Pa	325	452,606	193	66,451	245	37,080	763	556,137	30	174,622
Atlanta, Ga	587	1,505,421	1,103	338,823	101	46,518	1,791	1,890,762	78	1,019,056
Augusta, Ga	201	307,971	840	60,551	.....	.....	1,041	368,522	28	234,494
Baltimore, Md	95	429,918	.....	.....	.....	.....	95	429,918	1,703	5,358,726
Bayonne, N. J	125	404,585	229	74,379	68	19,851	422	498,815	45	396,109
Berkeley, Cal	384	1,351,375	709	292,650	.....	.....	1,093	1,644,025	9	239,400
Binghamton, N. Y	689	744,026	1,026	230,980	.....	.....	1,715	975,006	[a] 155	[a] 544,001
Birmingham, Ala	643	855,475	3,502	313,418	.....	.....	4,145	1,168,893	44	332,704
Boston, Mass	1,219	4,766,488	2,194	867,451	.....	.....	3,413	5,633,939	445	13,135,925
Bridgeport, Conn	925	2,584,233	152	91,027	266	110,442	1,343	2,785,702	210	5,266,466
Brockton, Mass	354	654,718	175	138,375	.....	.....	529	793,093	14	318,900
Brooklyn, N. Y	891	2,890,685	[b] 9,394	[b] 5,301,251	182	150,865	10,467	8,342,801	3,431	35,710,500
Buffalo, N. Y	2,858	5,505,000	1,578	848,000	.....	.....	4,436	6,353,000	324	4,527,000
Butte, Mont	[c]	410,643	[c]	60,409	.....	.....	[c]	471,052	[c]	327,025
Cambridge, Mass	200	1,017,055	286	162,220	.....	.....	486	1,179,275	49	1,376,930
Camden, N. J	84	168,000	153	61,600	101	33,900	338	263,500	822	1,664,000
Canton, Ohio	477	796,535	96	58,575	.....	.....	573	855,110	133	900,880
Charleston, S. C	183	205,193	213	61,668	.....	.....	396	266,861	8	40,552
Chester, Pa	49	8,225	.....	.....	5	5,650	54	13,875	202	592,200
Cincinnati, Ohio	1,451	1,889,139	[d]	[d]	.....	.....	1,451	1,889,139	[d] 1,062	[d] 10,136,385
Cleveland, Ohio	3,441	10,625,500	2,165	887,036	7,417	1,601,869	13,023	13,114,405	[e] 992	[e] 18,147,370

[a] New concrete buildings for Binghamton are included with new brick buildings.
[b] Additions, etc., to all classes of fire-resisting buildings for Brooklyn are included with additions, etc., to wooden buildings.
[c] The number of permits or buildings for Dallas was not given. The grand total only, i. e., 677 permits or buildings, for Butte was given.
[d] All classes of new fire-resisting buildings for Cincinnati are included with new brick buildings, and additions, etc., to all classes of buildings are included with additions, etc, to brick buildings.
[e] New concrete and new steel skeleton buildings and miscellaneous operations, fire-resisting buildings, for Cleveland are included with new brick buildings. Additions, etc., concrete and steel skeleton buildings for Cleveland are included with additions, etc., to brick buildings.

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Building statistics of the leading cities of the United States in 1915—Continued.

City.	Wooden buildings.								Fire-resisting buildings.	
	New.		Additions, alterations, and repairs.		Miscellaneous.		Total.		Brick or hollow tile, new.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Columbus, Ohio	1,226	$1,618,970	603	$141,270	.....	.....	1,829	$1,760,240	448	$2,140,955
Covington, Ky	106	119,440	59	18,435	.....	.....	165	137,875	100	273,075
Dayton, Ohio	850	1,684,900	202	29,640	.....	.....	1,052	1,714,540	52	156,000
Des Moines, Iowa	650	1,267,861	35	21,100	2	$1,390	687	1,290,351	66	506,550
Detroit, Mich	6,102	13,974,370	1,174	765,730	.....	.....	7,276	14,740,100	1,004	9,115,500
Duluth, Minn	788	1,159,043	827	272,268	.....	.....	1,615	1,431,311	63	473,111
East St. Louis, Ill	206	189,466	132	99,341	34	3,457	372	292,264	97	333,356
Elizabeth, N. J	268	773,051	109	93,572	.....	.....	377	866,623	47	358,428
Elmira, N. Y	120	268,800	.....	.....	.....	.....	120	268,800	15	268,800
Erie, Pa	577	970,009	557	395,400	.....	.....	1,134	1,365,409	122	560,646
Fall River, Mass	410	1,244,739	233	114,850	.....	.....	643	1,359,589	19	353,727
Fitchburg, Mass	126	312,414	87	72,699	3	1,550	216	386,663	11	91,200
Flint, Mich	1,332	1,507,505	310	128,948	.....	.....	1,642	1,636,453	70	326,126
Fort Worth, Tex	253	329,733	277	117,901	.....	.....	530	447,634	44	369,874
Galveston, Tex	717	805,645	2,903	325,270	.....	.....	3,620	1,130,915	19	394,600
Grand Rapids, Mich	974	1,127,700	694	214,382	.....	.....	1,668	1,342,082	87	742,807
Harrisburg, Pa	69	50,250	34	11,125	.....	.....	103	61,375	a 504	a 1,367,575
Hartford, Conn	751	2,059,594	300	178,980	.....	.....	1,051	2,238,574	189	2,518,426
Haverhill, Mass	291	760,550	74	99,400	.....	.....	365	859,950	15	138,200
Hoboken, N. J	18	19,220	90	44,807	.....	.....	108	64,027	16	216,650
Holyoke, Mass	92	227,715	42	36,430	.....	.....	134	264,145	32	489,350
Houston, Tex	715	975,413	3,071	439,703	57	32,814	3,843	1,447,930	28	277,004
Indianapolis, Ind	1,739	3,664,157	2,221	1,026,607	250	117,747	4,210	4,808,601	79	443,523
Jacksonville, Fla	271	521,665	239	135,786	.....	.....	510	657,451	b 26	b 723,030
Kalamazoo, Mich	83	177,500	100	70,200	.....	.....	183	247,700	10	29,000
Kansas City, Kans	370	470,020	152	63,876	164	28,783	686	562,679	43	314,650
Kansas City, Mo	1,297	3,285,600	907	464,425	691	178,375	2,895	3,928,400	275	4,469,900
Knoxville, Tenn	82	158,604	515	36,685	.....	.....	597	195,289	16	224,070
Lancaster, Pa	.....	.....	.....	.....	.....	.....	.....	.....	302	705,100
Lawrence, Mass	185	1,021,900	121	107,994	.....	.....	306	1,129,894	9	165,000
Lincoln, Nebr	369	899,744	113	67,960	.....	.....	482	967,704	38	337,700
Los Angeles, Cal	4,454	6,804,182	1,994	804,807	6	11,075	6,454	7,620,064	276	2,827,132
Louisville, Ky	655	1,425,870	783	138,480	395	56,430	1,833	1,620,780	123	1,088,500
Lowell, Mass	306	558,975	326	177,073	.....	.....	632	736,048	43	200,975
Lynn, Mass	354	762,075	246	190,684	.....	.....	600	952,759	19	461,000
McKeesport, Pa	.....	.....	57	63,805	.....	.....	57	63,805	72	488,397

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Macon, Ga	135	167,470	c 492	c 150,910			627	318,380	16	658,754
Manchester, N. H	456	822,414	600	253,645			1,056	1,076,059	11	486,000
Milwaukee, Wis	1,729	3,951,243	1,176	1,155,688	91	28,260	2,996	5,135,191	329	2,409,222
Minneapolis, Minn	3,738	6,771,950	2,283	1,037,400			6,021	7,809,350	254	4,001,555
Mobile, Ala	86	62,000	38	9,150			124	71,150	15	28,050
Montgomery, Ala	109	107,365	356	74,823			465	182,188	20	128,092
Newark, N. J	1,329	1,750,132					1,329	1,750,132	700	4,702,087
New Bedford, Mass	397	1,452,050	316	250,085	128	68,830	841	1,770,965	40	842,671
New Britain, Conn	537	675,145					537	675,145	96	805,640
New Haven, Conn	849	2,267,210	d 324	d 190,400	(d)	(d)	1,173	2,457,610	d 212	d 4,390,708
New York, N. Y	147	544,455	303	278,045	28	10,350	478	832,850	1,067	40,491,494
Norfolk, Va	264	432,511	88	37,997	84	47,693	436	518,201	160	991,263
Oakland, Cal	1,677	2,984,903	1,514	476,231			3,191	3,461,134	65	568,626
Oklahoma, Okla	259	622,655	144	94,026			403	717,681		
Omaha, Nebr	811	2,138,350	115	28,290	143	55,500	1,069	2,222,640	99	823,050
Passaic, N. J	106	217,906	78	36,725	24	1,086	208	255,667	67	683,229
Paterson, N. J	282	705,361	563	145,404			845	850,765	79	637,692
Pawtucket, R. I	179	542,230	171	61,425			350	603,655	27	213,700
Philadelphia, Pa	190	248,130	52	40,975	168	18,600	410	307,705	10,429	29,284,060
Pittsburgh, Pa	486	1,215,000	1,200	914,325	871	864,325	2,557	2,993,650	1,100	8,250,000
Portland, Oreg	1,966	2,635,415	1,910	456,175	109	25,795	3,985	3,117,385	77	838,235
Providence, R. I	1,105	2,656,300	2,322	471,900			3,427	3,128,200	130	2,028,200
Pueblo, Colo	59	50,115	11	3,550	26	4,990	96	58,655	46	115,865
Quincy, Ill	33	75,500					33	75,500	45	300,200
Reading, Pa	(e)	e 8,650	(e)	(e)			(e)	8,650	235	694,700
Richmond, Va	261	508,677	430	103,422			691	612,099	614	2,245,329
Rochester, N. Y	1,911	4,885,614	809	364,432	49	14,140	2,769	5,264,186	161	2,290,457
Sacramento, Cal	186	431,436	762	247,989			948	679,405	24	153,391
Saginaw, Mich	(f)	331,166	(f)	96,950			(f)	478,116	(f)	388,230
St. Joseph, Mo	108	217,950	159	81,455	131	16,545	398	315,950	38	592,007
St. Louis, Mo	2,898	395,787	1,275	180,068			4,173	575,855	a 1,951	a 9,248,363
St. Paul, Minn	1,217	3,293,229	824	358,674			2,041	3,651,903	198	2,331,269
Salem, Mass	428	1,595,810	98	109,298			526	1,705,108	110	1,721,526
Salt Lake City, Utah	210	171,791	65	33,815			275	205,606	735	1,855,356
San Antonio, Tex	773	873,115	669	145,230	466	42,295	1,908	1,060,640	38	216,080
San Diego, Cal	746	726,605	c 681	c 181,998			1,427	908,603	65	227,188
San Francisco, Cal	1,851	6,083,675	3,947	978,154			5,798	7,061,829	106	2,118,304
Savannah, Ga	410	659,490	143	59,825	88	17,695	641	737,010	51	339,005
Schenectady, N. Y	23	38,690	4	1,000			27	39,690	4	34,800

a All classes of new fire-resisting buildings for Harrisburg and St. Louis, are included with new brick buildings, and additions, etc., to all classes of fire-resisting buildings for Harrisburg are included under this head.

b New stone, new concrete, and new steel skeleton buildings for Jacksonville are included with new brick buildings, and additions, etc., to concrete and steel skeleton buildings are included with additions, etc., to brick buildings.

c Additions, etc., to all classes of fire-resisting buildings for San Diego are included with additions, etc., to wooden buildings. Additions, etc., to brick buildings for Macon are included with additions, etc., to wooden buildings.

d Miscellaneous operations, wooden buildings for New Haven, are included with additions, etc., to wooden buildings, and all fire-resisting buildings are included with new brick buildings.

e Additions, etc., to wooden buildings for Reading are included with new wooden buildings. The number of permits or buildings for these classes of buildings for Reading was not given, nor was it given for miscellaneous operations, fire-resisting buildings, nor for additions, etc., to each class of fire-resisting buildings.

f The number of permits or buildings for Saginaw was not given.

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Building statistics of the leading cities of the United States in 1915—Continued.

City.	Wooden buildings.								Fire-resisting buildings.	
	New.		Additions, alterations, and repairs.		Miscellaneous.		Total.		Brick or hollow tile, new.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Scranton, Pa.	234	$655,710	254	$136,762	211	$52,844	699	$845,316	[a] 15	[a] $306,737
Seattle, Wash.	3,473	2,744,485	4,235	695,690	225	20,305	7,933	3,460,480	[b] 51	[b] 2,726,400
Sioux City, Iowa.	455	1,144,012	.....	.....	.....	.....	455	1,144,012	68	678,840
South Bend, Ind.	[c] 329	[c] 401,336	(c)	(c)	.....	.....	329	401,336	40	367,909
Spokane, Wash.	250	183,480	400	157,100	.....	.....	650	340,580	54	460,000
Springfield, Ill.	196	441,943	137	88,680	.....	.....	332	530,623	61	589,345
Springfield, Mass.	684	1,801,040	401	163,228	(d)	4,213	1,085	1,968,481	252	3,728,317
Superior, Wis.	401	417,243	376	107,562	.....	.....	777	524,805	12	114,560
Syracuse, N. Y.	677	1,640,058	879	585,475	97	15,196	1,653	2,240,729	[e] 217	[e] 2,045,582
Tacoma, Wash.	415	404,221	492	114,923	181	25,558	1,088	544,702	7	47,788
Tampa, Fla.	646	634,150	824	106,848	38	10,890	1,508	751,888	27	494,896
Terra Haute, Ind.	287	311,271	211	49,695	.....	.....	498	360,966	19	88,275
Topeka, Kans.	300	485,469	124	53,581	.....	.....	424	539,050	17	75,716
Troy, N. Y.	63	266,550	424	35,931	.....	.....	487	302,481	26	517,400
Utica, N. Y.	359	725,720	67	112,850	.....	.....	426	838,570	79	423,925
Washington, D. C.	243	712,495	576	115,332	490	23,872	1,309	851,699	1,234	[f] 7,553,420
West Hoboken, N. J.	24	22,545	80	43,998	.....	.....	104	66,543	38	240,061
Wheeling, W. Va.	51	77,698	311	56,068	.....	.....	362	133,766	21	259,269
Wichita, Kans.	115	279,790	57	1,906	.....	.....	172	281,695	48	446,410
Wilkes-Barre, Pa.	197	245,698	273	103,179	290	47,930	760	396,807	167	497,521
Woonsocket, R. I.	164	326,462	78	38,867	.....	.....	242	365,329	13	62,150
Worcester, Mass.	962	2,048,749	[g] 717	[g] 1,328,397	.....	.....	1,679	3,377,146	[g] 125	[g] 1,149,236
Yonkers, N. Y.	264	762,800	61	124,300	.....	.....	325	887,100	124	1,589,200
York, Pa.	32	37,220	243	84,275	.....	.....	275	121,495	98	147,545
	82,810	163,185,471	79,344	30,585,392	13,930	3,855,458	176,084	197,626,321	37,367	292,963,820
Percentage of total	.....	24.93	.....	4.67	.....	.59	.....	30.19	.....	44.75

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City.	Fire-resisting buildings—Continued.											
	Brick or hollow tile—Continued.		Stone.				Concrete.				Steel skeleton.	
	Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.		New.		Additions, alterations, and repairs.		New.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Akron, Ohio	112	$256,825										
Albany, N. Y	36	179,125										
Allentown, Pa	85	94,705	5	$78,100	3	$45,100	4	$1,500	2	$1,800		
Altoona, Pa	34	26,125					1	20,000				
Atlanta, Ga	802	721,196					16	632,000			1	$275,000
Augusta, Ga	46	55,036										
Baltimore, Md											40	1,568,363
Bayonne, N. J	11	34,266					4	47,604				
Berkeley, Cal												
Binghamton, N. Y							(e)	(e)				
Birmingham, Ala	323	224,126					4	153,188	5	6,600		
Boston, Mass	2,096	3,356,630	2	95,500	101	211,431	51	1,733,094	31	96,221	126	4,417,392
Bridgeport, Conn	43	196,871					20	345,435	19	195,800		
Brockton, Mass	10	22,000										
Buffalo, N. Y	31	142,000	2	63,000			6	618,000				
Butte, Mont	(d)	46,130					(d)	174,225	(d)	5,600		
Cambridge, Mass	41	89,060			2	36,300	27	678,295	3	1,600		
Camden, N. J	115	69,000	1	170,000							5	124,500
Canton, Ohio	15	70,100					6	179,100				
Charleston, S. C	32	10,467										
Chester, Pa	17	34,400	7	62,000	1	2,000	4	4,950			1	50,000

a New steel skeleton buildings for Scranton are included with new brick buildings.

b All classes of new fire-resisting buildings for Seattle are included with new brick buildings. Additions, etc., to all classes of fire-resisting buildings for Seattle are included with additions, etc., to brick buildings.

c Additions, etc., to wooden buildings for South Bend are included with new wooden buildings.

d The grand total only, i. e., 677 permits or buildings, for Butte was given. The number of permits or buildings for miscellaneous operations, wooden buildings, for Springfield, Mass., was not given.

e New concrete buildings for Binghamton are included with new brick buildings.

f The cost of Government buildings for Washington, D. C., for which the number of permits or buildings was not given, is included with new brick buildings and with additions, etc., to brick buildings.

g Additions, etc., to all classes of fire-resisting buildings for Worcester are included with additions, etc., to wooden buildings. All classes of new fire-resisting buildings for Worcester are included with new brick buildings.

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Building statistics of the leading cities of the United States in 1915—Continued.

City.	Fire-resisting buildings—Continued.											
	Brick or hollow tile—Continued.		Stone.				Concrete.				Steel skeleton.	
	Additions, alterations and repairs.		New.		Additions, alterations and repairs.		New.		Additions, alterations and repairs.		New.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Cincinnati, Ohio	[a] 2,284	[a] $1,417,890										
Cleveland, Ohio	[b] 436	[b] 1,398,530					(b)	(b)	(b)	(b)	(b)	(b)
Columbus, Ohio	387	522,110	1	$400	4	$10,995	49	$210,115	14	$11,855	1	$225,000
Covington, Ky	40	40,450										
Dayton, Ohio	32	11,200					58	739,140	2	31,810		
Des Moines, Iowa	13	118,000					2	52,000				
Detroit, Mich	545	2,853,040					46	3,142,750	28	896,500	34	1,032,075
Duluth, Minn	117	170,812					13	624,500	8	14,730		
East St. Louis, Ill			1	2,200			1	100,000			4	110,000
Elizabeth, N. J	19	33,589					10	75,761				
Elmira, N. Y							50	182,050			1	30,000
Erie, Pa	40	128,241										
Fall River, Mass	14	63,750	7	21,150	1	900	19	25,505	1	75		
Fitchburg, Mass	6	33,400					18	10,600				
Flint, Mich	29	77,300					1	25,000			1	40,000
Fort Worth, Tex	94	116,299	1	500			3	227,000	1	15		
Galveston, Tex	39	209,810					4	566,500				
Grand Rapids, Mich	80	349,364					66	120,800	3	1,950	5	126,944
Hartford, Conn	154	603,120	1	125,000			5	86,800	3	3,975		
Haverhill, Mass	19	81,950									3	317,200
Hoboken, N. J	69	148,383					2	373,000				
Holyoke, Mass	33	84,610									3	90,000
Houston, Tex	352	142,634					23	470,575	14	11,040		
Indianapolis, Ind	860	171,132					47	29,717	(c)	(c)	(c)	(c)
Jacksonville, Fla	[d] 100	[d] 121,277	(d)	(d)			(d)	(d)	(d)	(d)	(d)	(d)
Kalamazoo, Mich	25	52,950					2	20,000				
Kansas City, Kans	15	34,920					4	50,500				
Kansas City, Mo	221	380,705	9	155,000			14	1,628,500				
Knoxville, Tenn	56	73,685										
Lancaster, Pa	125	167,278					1	25,000				
Lawrence, Mass	22	165,050					7	13,300	5	22,950		

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Lincoln, Nebr.	23	58,610					22	33,035			2	300,000
Los Angeles, Cal.	[b] 1,102	[b] 787,366					12	354,100	(b)	(b)	1	300,000
Louisville, Ky.	374	512,550					8	556,900				
Lowell, Mass.	52	171,287					3	88,000	1	30,000		
Lynn, Mass.	27	209,900					9	56,624				
McKeesport, Pa.												
Macon, Ga.	(c)	(c)										
Manchester, N. H.	71	204,606	1	140,000			2	1,800	3	38,000	4	651,500
Milwaukee, Wis.	293	288,925					243	3,344,422			1	350,000
Minneapolis, Minn.	283	567,940	1	3,000	20	29,710	45	64,045	24	13,790	117	3,532,390
Mobile, Ala.	6	3,695										
Montgomery, Ala.	59	74,603										
Newark, N. J.							179	123,665			8	1,300,700
New Bedford, Mass.	30	164,748					1	200,000				
New Britain, Conn.												
New Haven, Conn.												
New York, N. Y.	2,930	6,828,178									189	51,725,670
Norfolk, Va.	69	159,664			1	65,000	7	116,800	1	15,000		
Oakland, Cal.	71	216,440					19	790,330	6	8,760		
Oklahoma, Okla.							27	446,255	2	500		
Omaha, Nebr.	131	261,950					8	1,470,000			2	550,000
Passaic, N. J.	45	135,435										
Paterson, N. J.	68	129,061	2	3,150			44	29,472	2	260		
Pawtucket, R. I.												
Philadelphia, Pa.	[f] 2,998	[f] 2,445,075	15	68,000	(f)	(f)	22	2,325,800	(f)	(f)	10	580,000
Pittsburgh, Pa.	234	1,117,370	4	225,000			15	1,550,000			6	91,000
Portland, Oreg.	439	418,330					29	142,645	[g] 90	[g] 69,250	3	309,500
Providence, R. I.	179	1,123,200	5	160,900	8	2,300	82	328,600			14	250,100
Pueblo, Colo.	11	20,700	1	14,000			7	3,365				
Quincy, Ill.							1	45,000				
Reading, Pa.	(h)	111,400	66	268,500	(h)	9,250	22	34,875	(h)	1,050	171	74,025
Richmond, Va.	405	387,324										
Rochester, N. Y.	207	350,053					128	529,525	82	64,242	9	565,000
Sacramento, Cal.	292	159,851					20	143,181	26	29,750	1	200,000
Saginaw, Mich.	(i)	133,088										
St. Joseph, Mo.	8	7,863					1	22,500			1	1,000
St. Louis, Mo.	[f] 2,928	[f] 1,615,102										
St. Paul, Minn.	205	838,619					20	187,550			1	500,000

[a] All classes of new fire-resisting buildings for Cincinnati are included with new brick buildings, and additions, etc., to all classes of buildings are included with additions, etc., to brick buildings.

[b] New concrete and new steel skeleton buildings and miscellaneous operations, fire-resisting buildings, for Cleveland are included with new brick buildings. Additions, etc., to concrete and steel skeleton buildings for Cleveland and Los Angeles are included with additions, etc., to brick buildings.

[c] Additions, etc., to concrete buildings, new steel skeleton buildings, and additions, etc., to steel skeleton buildings and miscellaneous operations, fire-resisting buildings, were not separately classified for Indianapolis.

[d] New stone, new concrete, and new steel skeleton buildings for Jacksonville are included with new brick buildings.

[e] Additions, etc., to brick buildings for Macon are included with additions, etc., to wooden buildings.

[f] Additions, etc., to all classes of fire-resisting buildings for Philadelphia and St. Louis are included with additions, etc., to brick buildings.

[g] Additions, etc., to steel skeleton buildings for Portland, Oreg., are included with additions, etc., to concrete buildings.

[h] The number of permits or buildings for Reading was not given for miscellaneous operations, fire-resisting buildings, nor for additions, etc., to each class of fire-resisting buildings.

[i] The number of permits or buildings for Saginaw was not given.

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Building statistics of the leading cities of the United States in 1915—Continued.

City.	Fire-resisting buildings—Continued.											
	Brick or hollow tile—Continued.		Stone.				Concrete.				Steel skeleton.	
	Additions, alterations and repairs.		New.		Additions, alterations and repairs.		New.		Additions, alterations and repairs.		New.	
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.
Salem, Mass.	7	$61,585					3	$453,000				
Salt Lake City, Utah	215	189,758										
San Antonio, Tex.	93	109,290	2	$7,250			16	328,300	2	$16,500		
San Diego, Cal.							3	113,000				
San Francisco, Cal.	235	410,020	25	2,120,637	13	$100,000	82	2,029,884	202	150,030		
Savannah, Ga.	30	129,900					1	150,000			2	$25,000
Schenectady, N. Y.	1	1,500										
Scranton, Pa.	52	430,639									(a)	(a)
Seattle, Wash.	[b] 233	[b] 270,115										
Sioux City, Iowa.							15	227,565				
South Bend, Ind.							16	47,300				
Spokane, Wash.	150	155,087					3	245,000				
Springfield, Ill.	65	74,850										
Springfield, Mass.	158	369,596										
Superior, Wis.	20	63,915					12	216,545				
Syracuse, N. Y.	59	103,227	1	4,500			(c)	(c)			4	255,000
Tacoma, Wash.	117	90,184					4	107,750				
Tampa, Fla.	158	71,460					2	64,000	4	10,000		
Terra Haute, Ind.	47	40,815					17	88,665	1	150		
Topeka, Kans.	8	14,400	10	43,850			6	107,000				
Troy, N. Y.	93	121,937					5	59,900				
Utica, N. Y.	56	126,800									6	708,500
Washington, D. C.	1,468	[d] 1,266,566					9	2,450				
West Hoboken, N. J.	29	36,265					1	2,000				
Wheeling, W. Va.	235	183,138										
Wichita, Kans.	13	43,100	3	2,250			11	191,240				
Wilkes-Barre, Pa.	154	15,472	4	167,000								
Woonsocket, R. I.	9	51,050					5	30,700	1	25,000		
Worcester, Mass.												
Yonkers, N. Y.	49	132,600	6	48,100	11	3,900	13	164,300				
York, Pa.	248	42,139										
	27,667	39,507,882	183	3,988,987	165	516,886	1,788	31,003,592	586	1,774,893	777,588	70,675,859
Percentage of total		6.03		.61		.08		4.73		.27		10.80

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City.	Fire-resisting buildings—Continued.						Grand total.		Rank of cities in cost of buildings erected in 1915.
	Steel skeleton—Continued. Additions, alterations, and repairs.		Miscellaneous.		Total.				
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	
Akron, Ohio					403	$3,442,540	2,532	$6,030,950	28
Albany, N. Y					227	1,637,570	677	3,570,150	42
Allentown, Pa			10	$11,310	579	1,433,965	679	1,477,335	88
Altoona, Pa					65	220,747	828	776,884	123
Atlanta, Ga			64	51,200	961	2,698,452	2,752	4,589,214	36
Augusta, Ga					74	289,530	1,115	658,052	127
Baltimore, Md			119	2,184,884	1,862	9,111,973	1,957	9,541,801	18
Bayonne, N. J			9	18,330	69	496,309	491	996,124	108
Berkeley, Cal			(e)	e 710,000	9	949,400	1,102	2,593,425	58
Binghamton, N. Y					155	544,001	1,870	1,519,007	85
Birmingham, Ala					376	716,618	4,521	1,885,511	73
Boston, Mass	35	$339,185	28	94,375	2,915	23,479,753	6,328	29,113,692	7
Bridgeport, Conn					292	6,004,572	1,635	8,790,274	21
Brockton, Mass					24	340,900	553	1,133,903	102
Brooklyn, N. Y			617	1,548,550	f 4,048	f 37,259,050	14,515	45,601,851	3
Buffalo, N. Y			10	95,000	373	5,445,000	4,809	11,798,000	13
Butte, Mont					(g)	552,980	(g)	1,024,032	105
Cambridge, Mass			19	22,830	141	2,205,015	627	3,384,290	45
Camden, N. J			65	43,000	1,008	2,070,500	1,346	2,334,000	61
Canton, Ohio					154	1,150,080	727	2,005,190	71
Charleston, S. C			2	57,500	42	108,519	438	375,380	138
Chester, Pa			9	12,800	241	758,350	295	772,225	124

a New steel skeleton buildings for Scranton are included with new brick buildings.

b All classes of new fire-resisting buildings for Seattle are included with new brick buildings. Additions, etc., to all classes of fire-resisting buildings for Seattle are included with additions, etc., to brick buildings.

c New concrete buildings for Syracuse are included with new brick buildings.

d The cost of Government buildings for Washington, D. C., for which the number of permits or buildings was not given, is included with new brick buildings and with additions, etc., to brick buildings.

e With miscellaneous operations fire-resisting buildings for Berkeley are included the post office at Berkeley and buildings at the University of California. Permits for the latter were not issued through the city of Berkeley.

f Additions, etc., to all classes of fire-resisting buildings for Brooklyn, are included with additions, etc., to wooden buildings.

g The grand total only, i. e., 677 permits or buildings, for Butte was given.

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Building statistics of the leading cities of the United States in 1915—Continued.

City.	Fire-resisting buildings—Continued.						Grand total.		Rank of cities in cost of buildings erected in 1915.
	Steel skeleton—Continued.		Miscellaneous.		Total.				
	Additions, alterations, and repairs.								
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	
Cincinnati, Ohio					3,346	$11,554,275	4,797	$13,443,414	11
Cleveland, Ohio	(a)	(a)	(a)	(a)	1,428	19,545,900	14,451	32,080,305	5
Columbus, Ohio	4	$26,040	99	$20,715	1,007	3,168,185	2,836	4,928,425	33
Covington, Ky			30	4,310	170	317,335	335	455,710	135
Dayton, Ohio			38	881,990	182	1,820,080	1,234	3,534,620	43
Des Moines, Iowa			3	916	84	677,466	771	1,967,817	72
Detroit, Mich	33	455,575			1,990	17,495,440	8,966	32,235,540	6
Duluth, Minn					201	1,283,153	1,816	2,714,464	82
East St. Louis, Ill			12	415,438	115	960,994	487	1,253,258	94
Elizabeth, N. J			5	26,568	81	496,366	458	1,362,989	93
Elmira, N. Y					66	480,850	186	749,650	125
Erie, Pa					162	688,387	1,206	2,054,206	68
Fall River, Mass					61	455,107	704	1,894,696	76
Fitchburg, Mass			8	181,600	43	316,800	259	708,463	126
Flint, Mich					101	468,426	1,743	2,104,879	67
Fort Worth, Tex			8	5,585	151	719,273	681	1,166,907	100
Galveston, Tex			10	10,125	72	1,181,035	3,602	2,311,950	62
Grand Rapids, Mich					241	1,341,955	1,909	2,684,037	53
Harrisburg, Pa					504	1,367,575	607	1,428,950	89
Hartford, Conn					352	3,337,321	1,403	5,575,895	29
Haverhill, Mass			12	4,700	49	542,050	414	1,402,000	90
Hoboken, N. J					87	738,033	195	802,060	120
Holyoke, Mass					68	663,960	202	928,105	114
Houston, Tex	7	2,290	47	74,082	471	977,625	4,314	2,425,555	60
Indianapolis, Ind	(b)	(b)	b 981	b 1,630,669	1,967	2,275,041	6,177	7,083,642	24
Jacksonville, Fla	(c)	(c)	4	156,400	130	1,000,707	640	1,658,158	82
Kalamazoo, Mich			6	9,365	43	111,315	226	359,015	139
Kansas City, Kans					62	400,070	748	962,749	112
Kansas City, Mo			103	104,900	622	6,739,005	3,517	10,667,405	16
Knoxville, Tenn					72	297,755	669	493,044	134
Lancaster, Pa					428	897,378	428	897,378	116

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Lawrence, Mass					43	366,300	349	1,496,194	86
Lincoln, Nebr					85	729,345	567	1,697,049	78
Los Angeles, Cal	(a)	(a)			1,391	4,268,598	7,845	11,888 662	12
Louisville, Ky			94	276,660	599	2,434,610	2,432	4,055,390	39
Lowell, Mass			1	5,000	100	495,262	732	1,231,310	96
Lynn, Mass			5	5,430	60	732,954	660	1,685,713	80
McKeesport, Pa			30	7,640	102	496,037	159	559,842	131
Macon, Ga					16	658,754	643	977,134	109
Manchester, N. H					92	1,521,996	1,148	2,598,055	57
Milwaukee, Wis			20	36,565	886	6,429,134	3,882	11,564,325	14
Minneapolis, Minn	66	328,160			810	8,540,590	6,531	16,349,940	8
Mobile, Ala					21	31.745	145	102,895	143
Montgomery, Ala					79	202,695	544	384,883	137
Newark, N. J			331	35,600	1,218	6,162,052	d 2,547	d 7,912,184	22
New Bedford, Mass			100	148,350	171	1,355,769	1,012	3,126,734	47
New Britain, Conn					96	805,640	633	1,480,785	87
New Haven, Conn			139	256,629	351	4,647,337	1,524	7,104,947	23
New York, N. Y	565	2,802,877	2,465	342,721	7,236	102,190,950	7,714	103,023,800	1
Norfolk, Va					238	1,347,727	674	1,865,928	74
Oakland, Cal					161	1,584,156	3,352	5,045,290	32
Oklahoma, Okla			5	2,370	34	449,125	437	1,166,806	101
Omaha, Nebr			42	57,365	282	3,162,365	1,351	5,335,005	30
Passaic, N. J					112	818,664	320	1,074,331	104
Paterson, N. J	1	500	22	42,981	218	843,116	1,063	1,693,881	79
Pawtucket, R. I			73	18,060	100	231,760	450	835,415	118
Philadelphia, Pa	(e)	(e)			13,474	34,702,935	13,884	35,010,640	4
Pittsburgh, Pa					1,359	11,233,370	3,916	14,227,020	9
Portland, Oreg	(f)	(f)			638	1,777,960	4,623	4,895,345	34
Providence, R. I	3	2,200			421	3,895,500	3,848	7,023,700	25
Pueblo, Colo			4	7,325	60	161,255	165	219,910	142
Quincy, Ill					46	345,200	79	420,700	136
Reading, Pa	(g)	8,625	(g)	76,085	494	1,218,510	494	1,227,160	97
Richmond, Va					1,019	2,632,653	1,710	3,244,752	46
Rochester, N. Y			35	44,870	622	3,844,147	3,391	9,108,333	20
Sacramento, Cal					363	716,173	1,311	1,395,578	92
Saginaw, Mich					(h)	521,318	(h)	999,434	107
St. Joseph, Mo			28	3,450	71	626,820	469	942,770	113
St. Louis, Mo	(e)	(e)			4,879	10,863,465	9,052	11,439,320	15
St. Paul, Minn			223	1,728,117	647	5,585,555	2,688	9,237,458	19

a Miscellaneous operations, fire-resisting buildings, for Cleveland are included with new brick buildings. Additions, etc., to steel skeleton buildings for Cleveland and Los Angeles are included with additions, etc., to brick buildings.

b Additions, etc., to steel skeleton buildings and miscellaneous operations, fire-resisting buildings, were not separately classified for Indianapolis.

c Additions, etc., to concrete and steel skeleton buildings for Jacksonville are included with additions, etc., to brick buildings.

d Additions, etc., to all classes of buildings were not separately classified for Newark and are included in the total.

e Additians, etc., to all classes of fire-resisting buildings for Philadelphia and St. Louis are included with additions, etc., to brick buildings.

f Additions, etc., to steel skeleton buildings for Portland, Oreg., are included with additions, etc., to concrete buildings.

g The number of permits or buildings for Reading was not given for miscellaneous operations, fire-resisting buildings, nor for additions, etc., to each class of fire-resisting buildings.

h The number of permits or buildings for Sagina w was not given.

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Building statistics of the leading cities of the United States in 1915—Continued.

City.	Fire-resisting buildings—Continued.						Grand total.		Rank of cities in cost of buildings erected in 1915.
	Steel skeleton—Continued.		Miscellaneous.		Total.				
	Additions, alterations, and repairs.								
	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	Number of permits or buildings.	Cost.	
Salem, Mass					120	2,236,111	646	3,941,219	40
Salt Lake City, Utah					950	2,045,114	1,225	2,250,720	63
San Antonio, Tex			1	$5,800	152	$683,220	2,060	$1,743,960	77
San Diego, Cal					[a] 68	[a] 340,188	1,496	1,248,791	95
San Francisco, Cal					663	6,928,875	6,461	13,990,704	10
Savannah, Ga			2	800,000	86	1,443,950	727	2,180,960	64
Schenectady, N. Y					5	36,300	32	75,990	144
Scranton, Pa			18	100,900	85	838,276	784	1,683,592	81
Seattle, Wash					284	2,996,515	8,217	6,456,995	26
Sioux City, Iowa					83	906,405	538	2,050,417	69
South Bend, Ind					56	415,202	385	816,538	119
Spokane, Wash					207	860,087	857	1,200,667	98
Springfield, Ill					126	664,195	458	1,194,818	99
Springfield, Mass					410	4,097,913	1,496	6,066,394	27
Superior, Wis					44	395,020	821	919,825	115
Syracuse, N. Y			(b)	44,278	281	2,452,587	1,934	4,693,316	35
Tacoma, Wash					128	245,722	1,216	790,424	121
Tampa, Fla			32	3,800	223	644,156	1,731	1,396,044	91
Terra Haute, Ind			8	103,525	92	271,430	590	632,396	128
Topeka, Kans					41	240,966	465	780,016	122
Troy, N. Y					124	699,237	611	1,001,718	106
Utica, N. Y			17	13,400	158	1,272,625	584	2,111,195	66
Washington, D. C			408	75,166	3,119	8,807,602	4,428	9,749,301	17
West Hoboken, N. J					68	278,326	172	344,869	140
Wheeling, W. Va			1	10,000	307	452,407	669	586,173	130
Wichita, Kans					75	683,000	247	964,695	111
Wilkes-Barre, Pa					325	679,993	1,085	1,076,800	103
Woonsocket, R. I					28	168,900	270	534,229	132
Worcester, Mass					[a] 125	[a] 1,149,236	1,794	4,526,382	37
Yonkers, N. Y			17	5,300	220	1,943,400	545	2,830,500	50
York, Pa					346	189,084	621	311,179	141
	714	$3,965,452	6,434	12,636,499	75,681	457,033,870	251,765	654,660,191	
Percentage of total		.61		1.93		69.81		100.00	

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	Number of permits or buildings.	Cost.	Rank of cities in cost of buildings erected in 1915.
Atlantic City, N. J.	1,808	$2,144,215	65
Bay City, Mich.	443	514,375	133
Chattanooga, Tenn.	2,525	613,690	129
Chicago, Ill.	10,340	97,291,400	2
Dallas, Tex.	(c)	3,422,512	44
Denver, Colo.	3,085	2,648,575	54
Dubuque, Iowa.	312	970,000	110
El Paso, Tex.	1,540	3,612,418	41
Fort Wayne, Ind.	702	2,009,415	70
Jersey City, N. J.	1,306	5,351,630	31
Malden, Mass.	376	893,985	117
Memphis, Tenn.	2,303	2,730,488	51
New Orleans, La.	1,334	2,950,357	49
Newton, Mass.	843	3,073,079	48
Peoria, Ill.	640	4,090,645	38
Portland, Me.	519	1,557,469	83
Somerville, Mass.	480	1,854,236	75
Trenton, N. J.	892	2,648,396	55
Waterbury, Conn.	748	2,600,350	56
Wilmington, Del.	723	1,524,879	84
Youngstown, Ohio.	1,108	2,573,555	59
Grand total.	283,792	799,735,860	.....

a Additions, etc., to all classes of fire-resisting buildings for San Diego and Worcester are included with additions, etc., to wooden buildings. All classes of new fire-resisting buildings for Worcester are included with new brick buildings.

b The number of permits for buildings for miscellaneous operations, fire-resisting buildings for Syracuse was not given.

c The number of permits or buildings for Dallas was not given.

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The 144 cities included in this table reported building operations costing $799,735,860 in 1915, and of this number 123 cities reported sufficient detail to permit the publication of statistics of operations by classes of structures. These 123 cities reported 251,765 permits or buildings that cost $654,660,191. Of this total, new buildings of every variety cost $561,817,729, or over five-sixths of the total; additions, alterations, and repairs cost $76,350,505, or nearly one-eighth of the total; and miscellaneous operations cost $16,491,957, or about 3 per cent of the total.

It should be borne in mind, however, that these statistics of building operations by kinds, especially in the totals, are only approximate, as many cities were unable to report strictly in accordance with the classification given in the table. It is believed, however, that the figures as published are accurate enough to give a good idea of the relative importance of the various kinds of operations enumerated.

The rank of the several cities in the different varieties of building operations is probably relative and not actual, as some of the cities for which no details can be published may have exceeded some of the cities reporting in cost of the classes of buildings.

Taken by classes, the new wooden buildings in 1915 in these 123 cities cost $163,185,471, or 25 per cent of the total cost of all operations, and new brick buildings cost $292,963,820, or 45 per cent of the total. All other new buildings cost $105,668,438, or 16 per cent of the total. Of the total cost of new buildings, those constructed of wood constituted 29 per cent, and new fire-resisting buildings cost $398,632,258, or 71 per cent. The cost of new brick or hollow tile buildings constituted 52 per cent of the cost of all new buildings. Of the cost of all additions, alterations, and repairs, $30,585,392, or 40 per cent, was for wooden buildings, and 52 per cent was for brick or hollow tile buildings.

Operations on brick or hollow tile buildings (new), additions, alterations, and repairs in these 123 cities cost $332,471,702, or 51 per cent of the total cost of all operations in these cities. In addition to the brick or hollow tile used in the construction of brick buildings, large quantities are also used in foundations, in chimneys to wooden buildings, and in the construction of nearly all fire-resisting buildings.

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NATURAL GAS.

By JOHN D. NORTHROP.

INTRODUCTION.

The first statistical report on the natural-gas industry issued by the United States Geological Survey was published in 1884 and included statistics for the years 1882, 1883, and 1884. Since 1884 the Survey has prepared an annual inventory showing the approximate value of the legitimate requisitions that have been made on the stores of this ideal fuel in the United States, and since 1906 this inventory has included a statement of the approximate volume of gas produced and utilized each year. The present chapter, which is the thirty-second in this series of statistical records, gives a review of the production and consumption of natural gas in the United States in 1915, an account of the principal developments in the gas fields of the gas-producing States, and brief notes on the trend of the natural-gas industry in other countries so far as conditions can be ascertained.

The term "production" as applied to the output of natural gas is used in this chapter in a restricted sense to designate only that portion of the natural gas that found commercial utilization during the year in review. No attempt has been made to compile data concerning the volume of gas, amounting to many millions of cubic feet, that reached the surface and escaped without performing any useful service. "Production" as here employed is, broadly considered, synonymous with "consumption," and were there no interstate transportation of natural gas, the use of the former term would be unnecessary. As, however, natural gas can readily be transported from productive localities in one State to markets in adjacent States, production and consumption in a given civil area rarely balance and the necessity for a distinction becomes apparent, as is evident from the following example: The State of New York produced, in 1915, nearly 8,000,000,000 cubic feet of natural gas, whereas its consumption in the same period was in excess of 18,700,000,000 cubic feet, showing that more than one-half the natural gas supply of New York was obtained from fields outside the State. The term "consumption," as the name implies, designates the quantity of natural gas utilized within a specified area, usually a civil division, irrespective of the source of the gas.

Values, unless otherwise specified, represent money received for natural gas at the point of ultimate consumption, without regard to

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intervening transactions. As a great part of the natural gas used in the United States is sold by the original owner at a flat rate per well, payable quarterly or annually, an attempt to determine the "spot" value, or value at the point of production, of the output of natural gas is impracticable. Where field meters are in use, the price received by the producer ranges from 1½ to 15 cents a thousand cubic feet, depending on the relative abundance of gas in the particular locality and on the nature of the market, whether predominantly domestic or industrial.

GENERAL STATEMENT.

The natural-gas industry in the United States is one of steadily increasing importance. In spite of the demands that have been made on the reserves in this country during the last 50 years and the consequent depletion of the supply in many localities—in Pennsylvania, Ohio, and Indiana especially—the total volume of natural gas produced and commercially utilized in 1915 exceeded all previous records, aggregating 628,578,842,000 cubic feet.

The magnitude of this output, which for convenience may be assumed to be made up of gas at the same temperature and pressure, can perhaps be comprehended more readily by a realization of the fact that a single gas holder large enough to contain it would be 1 mile in diameter and 5.4 miles high.

The year 1915 terminates the first decade in which statistics of the volume of natural gas produced annually in the United States have been collected. Prior to 1906 the greater portion of gas distributed in this country was sold at a flat rate per day or per month determined by the number of burners, stoves, furnaces, kilns, ovens, boilers, or glory holes supplied, and even an approximation of the volume involved was impossible. In 1904 and 1905 the meter for natural gas was perfected, and by 1906 its use had become so general as to render feasible an effort to obtain statistics of the volume of gas produced and consumed annually.

The result of the first year's canvass showed that approximately 388,842,562,000 cubic feet of gas, valued at $46,873,932, was produced in 1906 and distributed to 874,944 domestic and 9,074 industrial consumers at an average price of 12.1 cents a thousand cubic feet, the rate to domestic consumers averaging 22.7 cents a thousand and to industrial consumers 7.8 cents a thousand.

A comparison of these data with corresponding statistics for the year 1915 discloses a marvelous growth in the natural-gas industry during the last decade. The comparison shows increases of 62 per cent in volume of gas produced and consumed annually and of 116 per cent in the total market value of the annual consumption, but of only 4.02 cents in the average unit price to all consumers. It shows also an increase of 151 per cent in the number of domestic consumers served, but of only 5.62 cents in the average unit price paid by them for gas service; and an increase of 102 per cent in the number of industrial consumers, but of only 1.88 cents in the average unit price paid for industrial-gas service. To make this brief summary more complete it is only necessary to add that the volume of natural gas utilized for domestic purposes has increased from 110,405,808,000 to 217,202,943,000 cubic feet, a gain of 97 per cent, whereas the volume used for

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industrial purposes has increased from 278,436,754,000 to 411,375,899,000 cubic feet, or only 48 per cent, and that with regard to the total consumption the volume utilized for domestic purposes has increased from 18 per cent in 1906 to 35 per cent in 1915, whereas that used for industrial purposes has decreased from 72 per cent of the total consumption in 1906 to 65 per cent in 1915.

The relative proportion of each year's production that has been consumed for domestic purposes has gradually increased during the last decade, and it is believed that this proportion will increase more rapidly in the decade to come. The factors contributing to the basis of this opinion include recent progress in the general adoption of methods for conserving oil-field gas in underground reservoirs until conditions are favorable for its recovery, the steady growth of the use of high-power compressors, and the adoption of welded pipe for long-distance transmission. The perfection of methods now under development by which the oil in a given pool can be removed without the loss of the gas from gas-bearing strata distinct from the productive oil sands will go far toward conserving the most valuable supplies of gas in the country for a higher form of utilization than the

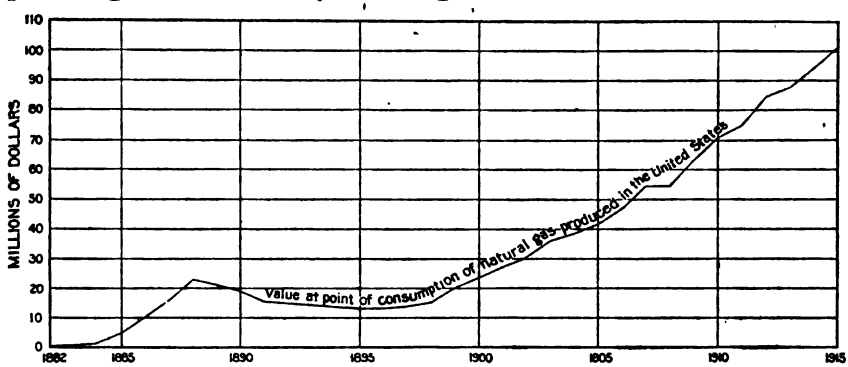

FIGURE 29.—Approximate value at point of consumption of natural gas produced and consumed annually in the United States, 1882–1915.

manufacture of carbon black, the burning of brick, or even the smelting of metals. The use of compressors and welded pipe is closely related to the future of the natural-gas industry in the United States, for their joint employment permits a large increase in the radius of the distribution of gas from the source of production. The costs of long-distance transmission are high, but, on the other hand, an average price of 28.32 cents a thousand, the average paid by domestic consumers of natural gas in the United States in 1915, is much less than the domestic consumer can afford to pay for gas of the type produced in West Virginia, for example, which contains from 50 to 100 per cent more heat units per cubic foot than the best artificial gas obtainable.

The total market value of the natural gas produced in the United States in 1915, which amounted to $101,312,381, constitutes not only a record compared with the market value of the gas produced in any preceding year, but also a milestone in the progress of the natural-gas industry in that it represents for the first time an output valued in excess of $100,000,000. Compared with the value of the

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output in 1882, the first year for which an estimate was made by the United States Geological Survey, the value of the 1915 production was 471.2 times greater. The value of the production in 1882 was $215,000.

The accompanying diagrams (figs. 29 and 30) show graphically the growth of the natural-gas industry in the United States since 1882.

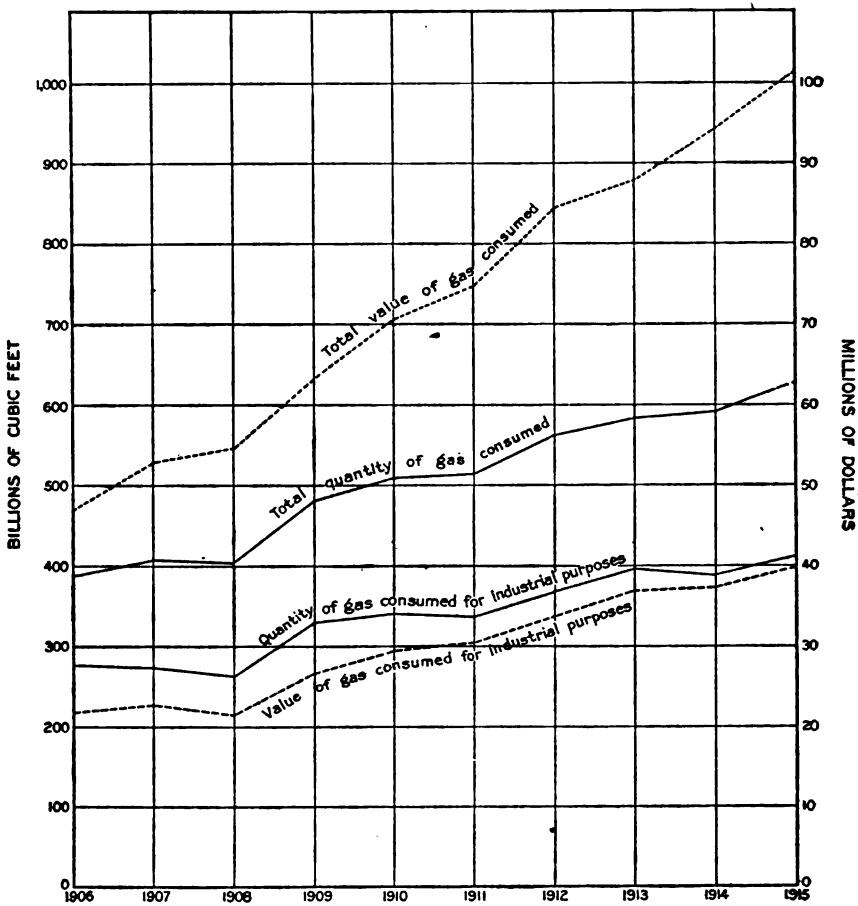

FIGURE 30.—Total quantity and total value of natural gas produced and consumed in the United States, 1906–1915, and quantity and value of gas distributed to industrial consumers, 1906–1915.

ACKNOWLEDGMENTS.

The author of this chapter gratefully acknowledges his indebtedness to the producers, transporters, and distributors of natural gas and to the manufacturers of casing-head gasoline in the United States, whose cordial cooperation and assistance have made possible the compilation of the statistical data here presented.

For supplemental data relating to current developments in the natural-gas industry, thanks are due to the Natural Gas Journal,

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Oil City Derrick, Oil and Gas Journal, Fuel Oil Journal, and California Oil World.

Especial acknowledgment is accorded to Miss Belle Hill, of the United States Geological Survey, author of a number of the preceding reports of this series, for valuable assistance and suggestions and for the compilation of the statistical tables presented in this report.

PRODUCTION.

The quantity of natural gas commercially utilized in the United States in 1915 is estimated to have amounted to 628,578,842,000 cubic feet, a volume which exceeds by nearly 37,000,000,000 cubic feet, or 6 per cent, the record established in 1914.

Credit for the increased production belongs, in the order given, to Ohio, Oklahoma, West Virginia, Pennsylvania, Kansas, and California, which together produced nearly 40,000,000,000 cubic feet more gas in 1915 than in 1914. Significant increases, important locally but unimportant in their effect on the production of the entire country, were credited to Arkansas, Wyoming, and Missouri.

The increase in the yield of gas may be attributed, in Ohio, to the remarkable success of drilling in the Cleveland gas field, Cuyahoga County; in Oklahoma, to a decided expansion in the casing-head gasoline industry and to a greater utilization of the vast reserves of gas in the Cushing district, Creek County; in West Virginia, to increased demand for gas from sources outside the State; in Pennsylvania, to increased demand within the State; in Kansas, to the continued development of the Augusta gas field, Butler County; and in California, to expanding markets in the southern part of the State and to increased use of casing-head gas for making gasoline.

CONSUMPTION.

The principal beneficiaries of the increased quantity of natural gas produced in the United States in 1915 were, in the order named: Pennsylvania, Oklahoma, Ohio, California, and Kansas, which together consumed nearly 38,000,000,000 cubic feet more gas in 1915 than in 1914.

It is estimated that of the record-breaking production of natural gas credited to 1915 a total of 217,202,943,000 cubic feet, or about 35 per cent, was supplied to domestic consumers at an average price of 28.32 cents a thousand cubic feet and that 411,375,899,000 cubic feet, comprising the remaining 65 per cent, was supplied to industrial consumers at an average price of 9.68 cents a thousand. Compared with statistics for 1914 these data show increases of 7 per cent in the volume of gas served to domestic consumers and of 6 per cent in the volume consumed industrially.

A further analysis of the statistics shows that approximately 275,379,749,000 cubic feet, or 67 per cent, of the industrial consumption in 1915, valued at $28,502,356, was consumed directly for manufacturing purposes in furnaces, kilns, and ovens employed in the iron, steel, brick, and glass industries, and that the remaining 33 per cent, valued at $11,308,088, was consumed indirectly in engines and under boilers in the generation of power.

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STATISTICS OF PRODUCTION AND CONSUMPTION.

The following tables show, by States, the statistics of natural gas produced and used in the United States from 1886 to 1915, inclusive:

Approximate value of natural gas produced and used in the United States, 1886–1915.

State.	1886	1887	1888	1889	1890	1891
Pennsylvania	$9,000,000	$13,749,500	$19,282,375	$11,593,989	$9,551,025	$7,334,016
New York	210,000	333,000	332,500	530,026	552,000	280,000
Ohio	400,000	1,000,000	1,500,000	5,215,669	4,684,300	3,076,325
West Virginia	60,000	120,000	120,000	12,000	5,400	35,000
Illinois	4,000	.....	.....	10,615	6,000	6,000
Indiana	300,000	600,000	1,320,000	2,075,702	2,302,500	3,942,500
Kansas	6,000	.....	.....	15,873	12,000	5,500
Missouri	.....	.....	.....	35,687	10,500	1,500
California	.....	.....	.....	12,680	33,000	30,000
Kentucky and Tennessee	.....	.....	.....	2,580	30,000	38,993
Texas and Alabama	.....	.....	.....	1,728	.....	.....
Arkansas and Wyoming	.....	.....	.....	375	.....	250
Other	32,000	15,000	75,000	1,600,175	1,606,000	250,000
	10,012,000	15,817,500	22,629,875	21,107,099	18,792,725	15,500,084

State.	1892	1893	1894	1895	1896	1897
Pennsylvania	$7,376,281	$6,488,000	$6,279,000	$5,852,000	$5,528,610	$6,242,543
New York	216,000	210,000	249,000	241,530	256,000	200,076
Ohio	2,136,000	1,510,000	1,276,100	1,255,700	1,172,400	1,171,777
West Virginia	70,500	123,000	395,000	100,000	640,000	912,528
Illinois	12,988	14,000	15,000	7,500	6,375	5,000
Indiana	4,716,000	5,718,000	5,437,000	5,203,200	5,043,635	5,009,206
Kansas	40,795	50,000	86,600	112,400	124,750	105,700
Missouri	3,775	2,100	4,500	3,500	1,500	500
California	55,000	62,000	60,350	55,000	55,682	50,000
Kentucky and Tennessee	43,175	68,500	89,200	98,700	99,000	15,090
Texas	100	50	50	20	.....	90,000
Alabama						.....
Arkansas and Wyoming	100	100	100	100	60	4,000
Utah	.....	500	500	20,000	20,090	.....
Colorado	.....	.....	12,000	7,000	4,500	.....
South Dakota	.....	.....	.....	.....	.....	20,000
Other	200,000	100,000	50,000	50,000	50,000	.....
	14,870,714	14,346,250	13,954,400	13,006,650	13,002,512	13,826,422

State.	1898	1899	1900	1901	1902	1903
Pennsylvania	$6,806,742	$8,337,210	$10,215,412	$12,688,161	$14,352,183	$16,182,834
New York	229,078	294,593	335,367	293,232	346,471	493,686
Ohio	1,488,308	1,866,271	2,178,234	2,147,215	2,355,458	4,479,040
West Virginia	1,334,023	2,335,864	2,959,032	3,954,472	5,390,181	6,882,359
Illinois	2,498	2,067	1,700	1,825	1,844	3,310
Indiana	5,060,969	6,680,370	7,254,539	6,954,566	7,061,344	6,098,364
Kansas	174,640	332,592	356,900	659,173	824,431	1,123,849
Missouri	145	290	547	1,328	2,154	7,070
California	65,337	86,891	79,083	67,602	120,648	104,521
Texas	103,133					
Alabama	765	8,000	20,000	18,577	14,953	13,851
Louisiana	.....					
Kentucky	.....	125,745	286,243	270,871	365,656	390,601
Tennessee	7,875					
Arkansas and Wyoming	3,300	.....	.....	.....	.....	2,460
Utah	.....	1,480	.....	.....	.....	.....
Colorado	.....	3,500	1,800	1,800	1,900	14,140
Oklahoma	.....	.....	.....	.....	360	1,000
South Dakota	20,000	.....	9,817	7,255	10,280	10,775
	15,296,813	20,074,873	23,698,674	27,066,077	30,867,863	35,807,860

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Approximate value of natural gas produced and used in the United States, 1886–1915—Continued.

State.	1904	1905	1906	1907	1908	1909
Pennsylvania	$18,139,914	$19,197,336	$18,558,245	$18,844,156	$19,104,944	$20,475,207
New York	522,575	623,251	672,795	766,157	959,280	1,222,666
Ohio	5,315,564	5,721,462	7,145,809	8,718,562	8,244,335	9,966,938
West Virginia	8,114,249	10,075,804	13,735,343	16,670,962	14,837,130	17,538,565
Illinois	4,745	7,223	87,211	143,577	446,077	644,401
Indiana	4,342,409	3,094,134	1,750,715	1,572,605	1,312,507	1,616,908
Kansas	1,517,643	2,261,836	4,010,986	6,198,583	7,691,587	8,293,846
Missouri	6,285	7,390	7,210	17,010	22,592	10,025
California	114,195	133,696	134,560	168,397	307,652	446,933
Texas	14,082	14,409	150,695	178,276	236,837	453,253
Alabama						
Louisiana		1,500				
Kentucky	322,404	237,290	287,501	380,176	424,271	485,192
Tennessee		300	300	300	350	350
Arkansas and Wyoming	6,515	21,135	34,500	126,582	164,930	226,926
Colorado	14,300	20,752	22,800			
Oklahoma	49,665	130,137	259,862	417,221	860,159	1,806,193
South Dakota	12,215	15,200	15,400	19,500	24,400	16,164
North Dakota				235	2,490	3,025
Oregon				100	250	50
Iowa					98	50
Michigan						255
	38,496,760	41,562,855	46,873,932	54,222,309	54,640,374	63,206,941

State.	1910	1911	1912	1913	1914	1915
Pennsylvania	$21,057,211	$18,520,796	$18,539,672	$21,695,845	$20,339,809	$21,139,605
New York	1,678,720	1,418,767	2,342,379	2,425,633	2,600,352	2,335,252
Ohio	8,626,954	9,367,347	11,891,299	10,521,930	14,667,790	17,391,060
West Virginia	23,816,553	28,435,907	33,324,475	34,164,850	35,076,755	36,424,263
Illinois	613,642	687,726	616,467	574,015	437,275	350,371
Indiana	1,473,403	1,192,418	1,014,295	843,047	755,407	695,380
Kansas	7,755,367	4,854,534	4,336,635	3,288,394	3,340,025	4,037,011
Missouri	12,611	10,496	11,576	6,795	5,319	7,731
California	476,697	800,714	1,134,456	1,883,450	2,910,784	4,069,004
Texas	956,683	1,014,945	1,405,077	2,073,823	2,469,770	2,503,873
Louisiana		858,145	1,747,379	2,119,948	2,224,999	2,163,934
Alabama						203,728
Arkansas						
Wyoming	301,151	295,858	309,816	269,421	214,108	
Colorado						62,398
Montana						
Kentucky	456,293	407,689	522,455	509,846	490,875	614,998
Tennessee	300	300	375	600	300	400
Oklahoma	3,490,704	6,731,770	7,334,599	7,436,389	8,050,039	9,195,804
South Dakota	31,999	16,984	30,412	31,166	27,220	25,809
North Dakota	7,010	5,738				
Iowa	40	70	120	120	200	250
Michigan	820	1,330	1,470	1,405	1,442	1,510
	70,756,158	74,621,534	84,568,957	87,846,677	94,115,524	101,312,381

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Natural gas produced and consumed in the United States in 1914 and 1915.

1914.

State.	Produced.			Consumed.		
	Quantity (M cubic feet).	Price (cents per M cubic feet).	Value.	Quantity (M cubic feet).	Price (cents per M cubic feet).	Value.
West Virginia	236,489,175	14.87	$35,076,755	95,147,247	7.71	$7,334,690
Pennsylvania	110,745,374	18.80	20,839,869	164,834,542	17.25	28,439,324
Ohio	68,270,174	21.48	14,667,790	138,388,914	21.63	29,936,642
Oklahoma	78,167,414	10.30	8,050,039	[a]55,544,105	7.61	4,226,318
Kansas	22,627,507	14.76	3,340,025	[b]45,250,816	15.83	7,163,746
California	17,828,928	16.33	2,910,784	17,828,928	16.33	2,910,784
New York	8,935,187	29.10	2,600,352	18,401,830	29.94	5,510,204
Texas	13,433,639	18.38	2,469,770	13,433,639	18.38	2,469,770
Louisiana	26,774,695	8.32	2,227,999	[c]26,774,695	8.32	2,227,999
Alabama						
Indiana	2,579,675	29.28	755,407	4,443,244	32.02	1,422,880
Kentucky	1,421,818	34.52	490,875	7,225,626	24.73	1,787,308
Illinois	3,547,841	12.32	437,275	[d]3,547,841	12.32	437,275
Arkansas	962,998	22.23	214,103	962,998	22.23	214,103
Colorado						
Wyoming						
South Dakota	60,781	44.78	27,220	60,781	44.78	27,220
North Dakota						
Missouri	18,085	29.41	5,319	18,085	29.41	5,319
Michigan	2,042	70.61	1,442	2,042	70.61	1,442
Tennessee	1,200	25.00	300	1,200	25.00	300
Iowa	200	100.00	200	200	100.00	200
	591,866,733	15.90	94,115,524	591,866,733	15.90	94,115,524

1915.

West Virginia	244,004,159	14.93	$36,424,263	94,976,705	7.85	$7,451,003
Pennsylvania	113,691,690	18.59	21,139,605	176,367,235	17.06	30,087,667
Ohio	79,510,032	21.87	17,391,060	146,724,989	21.74	31,900,764
Oklahoma	87,516,753	10.51	9,195,804	[a]65,691,366	7.70	5,058,526
California	21,891,035	18.59	4,069,004	21,891,035	18.59	4,069,004
Kansas	27,045,908	14.93	4,037,011	[b]48,871,295	16.73	8,174,289
Texas	13,323,747	19.47	2,593,873	13,323,747	19.47	2,593,873
New York	7,976,985	29.27	2,335,252	18,776,496	30.23	5,676,097
Louisiana	25,540,392	8.47	2,163,934	[c]25,540,392	8.47	2,163,934
Indiana	2,260,733	30.76	695,380	4,519,244	34.13	1,542,604
Kentucky	1,667,423	36.88	614,998	7,746,353	25.08	1,942,423
Illinois	2,690,593	13.02	350,371	[d]2,690,593	13.02	350,371
Arkansas	[e]1,022,308	19.93	203,728	1,022,308	19.93	203,728
Alabama						
Wyoming						
Colorado	347,397	17.96	62,398	347,397	17.96	62,398
Montana						
South Dakota	58,132	44.40	25,809	58,132	44.40	25,809
North Dakota						
Missouri	27,645	27.97	7,731	27,645	27.97	7,731
Michigan	2,060	73.30	1,510	2,060	73.30	1,510
Tennessee	1,600	25.00	400	1,600	25.00	400
Iowa	250	100.00	250	250	100.00	250
	628,578,842	16.12	101,312,381	628,578,842	16.12	101,312,381

[a] Includes gas piped from Oklahoma and consumed in Missouri.
[b] Includes gas piped from Kansas and consumed in Missouri.
[c] Includes gas piped from Louisiana and consumed in Arkansas and Texas.
[d] Includes gas piped from Illinois and consumed in Indiana.
[e] Includes gas piped from Oklahoma and consumed in Arkansas.

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Distribution of natural gas consumed in the United States in 1914.

State.	Number of producers.	Consumers.		Gas consumed.		
				Domestic.		
		Domestic.	Industrial.	Quantity (M cubic feet).	Price (cents per M cubic feet).	Value.
Ohio	2,268	734,354	6,102	71,873,699	29.11	$20,922,408
Pennsylvania	1,325	415,644	4,307	50,192,742	27.30	13,702,262
West Virginia [a]	475	108,277	1,850	17,023,701	18.64	3,173,961
Kansas [b]	353	187,714	1,079	19,214,194	25.49	4,898,314
New York	367	146,236	666	16,982,834	30.86	5,241,057
Oklahoma [c]	437	62,390	1,951	7,705,890	19.14	1,474,582
California	57	205,163	172	2,948,274	61.12	1,802,098
Texas	75	43,547	468	4,300,350	39.04	1,678,858
Louisiana [d]	54	29,751	618	3,762,874	26.96	1,014,467
Alabama	7	395	3			
Kentucky	101	78,505	128	4,222,495	34.99	1,477,530
Indiana [e]	1,029	43,410	344	3,404,551	33.74	1,148,683
Illinois [f]	235	8,952	153	771,191	27.33	210,787
Arkansas	7	5,830	6			
Colorado	15	1,206	11	657,690	29.28	192,592
Wyoming	17	543	12			
South Dakota	27	400	6			
North Dakota	13	61	.....	27,311	61.80	16,877
Missouri	49	126	7	14,420	29.60	4,269
Michigan	20	16	3	842	100.00	842
Tennessee	7	3	.....	1,200	25.00	300
Iowa	5	3	.....	200	100.00	200
	6,943	2,077,526	17,886	203,104,358	28.04	56,960,052

State.	Gas consumed.					
	Industrial.			Total.		
	Quantity (M cubic feet).	Price (cents per M cubic feet).	Value.	Quantity (M cubic feet).	Price (cents per M cubic feet).	Value.
Ohio	66,515,215	13.55	$9,014,234	138,388,914	21.63	$29,936,642
Pennsylvania	114,641,800	12.85	14,737,062	164,834,542	17.25	28,439,324
West Virginia [a]	78,123,546	5.33	4,160,759	95,147,247	7.71	7,334,690
Kansas [b]	26,036,622	8.70	2,265,432	45,250,816	15.83	7,163,746
New York	1,418,996	18.97	269,147	18,401,830	29.94	5,510,204
Oklahoma [c]	47,838,215	5.75	2,751,736	55,544,105	7.61	4,226,318
California	14,880,654	7.45	1,108,691	17,828,928	16.33	2,910,784
Texas	9,133,289	8.66	790,912	13,433,639	18.38	2,469,770
Louisiana [d]	23,011,911	5.27	1,213,532	26,774,695	8.32	2,227,999
Alabama						
Kentucky	3,003,131	10.32	309,778	7,225,626	24.73	1,787,308
Indiana [e]	1,038,693	26.40	274,197	4,443,244	32.02	1,422,880
Illinois [f]	2,776,650	8.16	226,488	3,547,841	12.32	437,275
Arkansas						
Colorado	305,318	7.05	21,511	962,998	22.23	214,103
Wyoming						
South Dakota						
North Dakota	33,470	30.90	10,343	60,781	44.78	27,220
Missouri	3,665	28.65	1,050	18,085	29.41	5,319
Michigan	1,200	50.00	600	2,042	70.61	1,442
Tennessee	.....	.....	.....	1,200	25.00	300
Iowa	.....	.....	.....	200	100.00	200
	388,762,375	9.56	37,155,472	591,866,733	15.90	94,115,524

[a] Includes the consumption of gas piped from West Virginia to Maryland.
[b] Includes the consumption of gas piped from Kansas to Missouri.
[c] Includes some gas piped from Oklahoma to Missouri.
[d] Includes the consumption of gas piped to Texas from Louisiana and to Arkansas from Louisiana.
[e] Includes the consumption of gas piped from Indiana to Chicago, Ill., and from West Virginia to Indiana.
[f] Includes the consumption of gas piped from Illinois to Vincennes, Ind.

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Distribution of natural gas consumed in the United States in 1915.

State.	Number of producers.	Consumers.		Gas consumed.		
				Domestic.		
		Domestic.	Industrial.	Quantity (M cubic feet).	Price (cents per M cubic feet).	Value.
Ohio	2,499	773,548	5,621	77,087,545	29.35	$22,626,560
Pennsylvania	1,396	440,673	4,696	51,348,384	27.28	14,009,226
Kansas [a]	371	201,133	1,446	20,629,792	25.83	5,329,260
West Virginia [b]	506	115,908	1,910	17,893,105	18.34	3,281,532
New York	346	153,972	815	17,309,353	31.19	5,398,084
Oklahoma [c]	434	67,874	1,551	10,047,410	17.97	1,805,826
California	59	207,673	257	4,210,915	66.70	2,808,781
Texas	65	59,386	677	4,926,607	37.72	1,858,308
Louisiana [d]	57	30,144	597	3,836,419	26.87	1,030,893
Kentucky	86	84,666	117	4,924,209	34.19	1,683,390
Indiana [e]	999	44,012	438	3,505,354	35.89	1,258,019
Illinois [f]	226	8,610	134	704,696	27.25	192,050
Arkansas [g]	9	5,797	59	653,973	26.00	170,042
Alabama	6	440	1			
Wyoming	17	599	10			
Colorado	14	7	8	71,661	35.18	25,211
Montana	2	1	1			
South Dakota	28	399	6	28,132	59.66	16,784
North Dakota	12	42	2			
Missouri	44	174	9	22,978	28.12	6,461
Michigan	16	14	2	960	100.00	960
Tennessee	8	6	1	1,200	25.00	300
Iowa	5	3	.....	250	100.00	250
	7,205	2,195,081	18,358	217,202,943	28.32	61,501,937

State.	Gas consumed.					
	Industrial.			Total.		
	Quantity (M cubic feet).	Price (cents per M cubic feet).	Value.	Quantity (M cubic feet).	Price (cents per M cubic feet).	Value.
Ohio	69,637,444	13.32	$9,274,204	146,724,989	21.74	$31,900,764
Pennsylvania	125,018,851	12.86	16,078,441	176,367,235	17.06	30,087,667
Kansas [a]	28,241,503	10.07	2,845,029	48,871,295	16.73	8,174,289
West Virginia [b]	77,083,600	5.41	4,169,471	94,976,705	7.85	7,451,003
New York	1,467,143	18.95	278,013	18,776,496	30.23	5,676,097
Oklahoma [c]	55,643,956	5.85	3,252,760	65,691,366	7.70	5,058,526
California	17,680,120	7.13	1,260,223	21,891,035	18.59	4,069,004
Texas	8,397,140	8.76	735,565	13,323,747	19.47	2,593,873
Louisiana [d]	21,703,973	5.22	1,133,041	25,540,392	8.47	2,163,934
Kentucky	2,822,144	9.18	259,033	7,746,353	25.08	1,942,423
Indiana [e]	1,013,890	28.07	284,585	4,519,244	34.13	1,542,604
Illinois [f]	1,985,897	7.97	158,321	2,690,593	13.02	350,371
Arkansas [g]	368,335	9.15	33,686	1,022,308	19.93	203,728
Alabama						
Wyoming						
Colorado	275,736	13.49	37,187	347,397	17.96	62,398
Montana						
South Dakota						
North Dakota	30,000	30.08	9,025	58,132	44.40	25,809
Missouri	4,667	27.21	1,270	27,645	27.97	7,731
Michigan	1,100	50.00	550	2,060	73.30	1,510
Tennessee	400	25.00	100	1,600	25.00	400
Iowa	.....	.....	.....	250	100.00	250
	411,375,899	9.68	39,810,444	628,578,842	16.12	101,312,381

[a] Includes the consumption of gas piped from Kansas to Missouri.
[b] Includes the consumption of gas piped from West Virginia to Maryland.
[c] Includes some gas piped from Oklahoma to Missouri.
[d] Includes the consumption of gas piped to Texas from Louisiana and to Arkansas from Louisiana.
[e] Includes the consumption of gas piped from Indiana to Chicago, Ill., and from West Virginia to Indiana.
[f] Includes the consumption of gas piped from Illinois to Vincennes, Ind.
[g] Includes the consumption of gas piped from Oklahoma to Arkansas.

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Distribution of natural gas consumed for industrial purposes in the United States in 1914.

State.	Industrial consumers.			Gas consumed.		
				Manufacturing.		
	Manufacturing.	Other industrial (power).	Total.	Quantity (M cubic feet).	Price (cents per M cubic feet).	Value.
Pennsylvania	1,934	2,373	4,307	104,073,315	12.86	$13,328,188
Ohio	3,781	2,321	6,102	49,572,360	13.26	6,574,104
West Virginia	736	1,114	1,850	56,378,902	5.30	2,987,428
Oklahoma	579	1,372	1,951	23,135,719	5.21	1,205,673
Kansas	407	672	1,079	15,154,758	7.93	1,201,495
Louisiana	97	521	618	2,873,340	6.09	195,742
Alabama	.....	3	3			
California	.....	172	172	.....	.....	.....
Texas	174	294	468	4,298,637	8.55	367,572
Kentucky	22	106	128	2,040,404	8.28	168,854
Indiana	286	58	344	737,195	29.24	215,519
New York	116	550	666	267,228	20.20	53,978
Illinois	6	147	153	435,115	8.76	38,116
Arkansas	(a)	6	6	(a)	.....	(a)
Colorado	.....	11	11			
Wyoming	.....	12	12			
South Dakota	.....	6	6	.....	.....	.....
North Dakota	.....	.....	.....	.....	.....	.....
Missouri	.....	7	7	.....	.....	.....
Michigan	.....	3	3	.....	.....	.....
	8,138	9,748	17,886	258,966,973	10.17	26,336,669

State.	Gas consumed.					
	Other industrial (power).			Total industrial.		
	Quantity (M cubic feet).	Price (cents per M cubic feet).	Value.	Quantity (M cubic feet).	Price (cents per M cubic feet).	Value.
Pennsylvania	10,568,485	13.33	$1,408,874	114,641,800	12.85	$14,737,062
Ohio	16,942,855	14.40	2,440,130	66,515,215	13.55	9,014,234
West Virginia	21,744,644	5.40	1,173,331	78,123,546	5.33	4,160,[illegible]9
Oklahoma	24,702,496	6.26	1,546,063	47,838,215	5.75	2,751,[illegible]36
Kansas	10,881,864	9.78	1,063,937	26,036,622	8.70	2,265,432
Louisiana	20,138,571	5.05	1,017,790	23,011,911	5.27	1,213,532
Alabama						
California	14,890,654	7.45	1,108,691	14,890,654	7.45	1,108,691
Texas	4,834,652	8.76	423,340	9,133,289	8.66	790,912
Kentucky	962,727	14.64	140,924	3,003,131	10.32	309,778
Indiana	301,498	19.46	58,678	1,038,693	26.40	274,197
New York	1,151,768	18.68	215,169	1,418,996	18.97	269,147
Illinois	2,341,535	8.00	188,372	2,776,650	8.16	226,488
Arkansas						
Colorado	305,318	7.05	21,511	305,318	7.05	21,511
Wyoming						
South Dakota						
North Dakota	33,470	30.90	10,343	33,470	30.90	10,343
Missouri	3,665	28.65	1,050	3,665	28.65	1,050
Michigan	1,200	50.00	600	1,200	50.00	600
	129,795,402	8.34	10,818,803	388,762,375	9.56	37,155,473

(a) Included in "Other industrial."

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Distribution of natural gas consumed for industrial purposes in the United States in 1915.

State.	Industrial consumers.			Gas consumed.		
				Manufacturing.		
	Manufacturing.	Other industrial (power).	Total.	Quantity (M cubic feet).	Price (cents per M cubic feet).	Value.
Pennsylvania	2,032	2,664	4,696	113,959,748	12.83	$14,618,980
Ohio	3,500	2,121	5,621	53,199,691	13.34	7,095,763
West Virginia	1,005	905	1,910	56,277,012	5.24	2,950,182
Oklahoma	323	1,228	1,551	28,336,632	5.25	1,489,021
Kansas	517	929	1,446	16,276,317	9.77	1,590,150
California		257	257			
Louisiana	93	504	597	2,455,305	7.56	185,501
Texas	56	621	677	1,244,925	6.46	80,441
Indiana	341	97	438	777,902	29.73	231,334
New York	28	787	815	246,986	17.96	44,357
Kentucky	36	81	117	2,424,063	8.38	203,184
Illinois	5	129	134	181,168	7.42	13,443
Wyoming		10	10			
Colorado		8	8			
Montana		1	1			
Arkansas	3	56	59	(a)		(a)
Alabama		1	1			
South Dakota		6	6			
North Dakota		2	2			
Missouri		9	9			
Michigan		2	2			
Tennessee		1	1			
	7,939	10,419	18,358	275,379,749	10.35	28,502,356

State.	Gas consumed.					
	Other industrial (power).			Total industrial.		
	Quantity (M cubic feet).	Price (cents per M cubic feet).	Value.	Quantity (M cubic feet).	Price (cents per M cubic feet).	Value.
Pennsylvania	11,059,103	13.19	$1,459,461	125,018,851	12.86	$16,078,441
Ohio	16,437,753	13.25	2,178,441	69,637,444	13.32	9,274,204
West Virginia	20,806,588	5.86	1,219,289	77,083,600	5.41	4,169,471
Oklahoma	27,307,324	6.46	1,763,679	55,643,956	5.85	3,252,700
Kansas	11,965,186	10.48	1,254,879	28,241,503	10.07	2,845,029
California	17,680,120	7.13	1,260,223	17,680,120	7.13	1,260,223
Louisiana	19,248,068	4.92	947,540	21,703,973	5.22	1,133,041
Texas	7,152,215	9.16	655,124	8,397,140	8.76	735,565
Indiana	235,988	23.01	53,251	1,013,890	28.07	284,585
New York	1,220,157	19.15	233,656	1,467,143	18.95	278,013
Kentucky	398,081	14.03	55,849	2,822,144	9.18	259,033
Illinois	1,804,729	8.03	144,878	1,985,897	7.97	158,321
Wyoming						
Colorado	275,736	13.49	37,187	275,736	13.49	37,187
Montana						
Arkansas						
Alabama	368,335	9.15	33,686	368,335	9.15	33,686
South Dakota						
North Dakota	30,000	30.08	9,025	30,000	30.08	9,025
Missouri	4,667	27.21	1,270	4,667	27.21	1,270
Michigan	1,100	50.00	550	1,100	50.00	550
Tennessee	400	25.00	100	400	25.00	100
	135,996,150	8.32	11,308,088	411,375,899	9.68	39,810,444

a Included in "Other industrial."

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Value of natural gas consumed in the United States, 1910–1915.

State.	1910	1911	1912	1913	1914	1915
Pennsylvania	$22,934,691	$23,940,001	$26,486,302	$28,709,565	$28,439,324	$30,087,667
Ohio	21,210,965	22,792,370	27,196,162	27,055,824	29,936,642	31,900,764
West Virginia	[a] 5,617,910	[a] 6,240,152	[a] 7,001,321	[a] 7,333,956	[a] 7,334,090	[a] 7,451,003
Kansas	[b] 9,335,027	[b] 9,493,701	[b] 8,521,858	[b] 6,983,804	[b] 7,163,746	[b] 8,174,289
New York	3,963,872	4,276,324	4,866,821	4,888,412	5,510,204	5,676,097
Oklahoma	1,911,044	2,092,003	3,149,376	3,740,981	4,226,318	5,068,526
Indiana	[c] 1,473,403	[c] 1,192,418	[c] 1,014,396	[c] 948,278	[c] 1,422,880	[c] 1,542,604
Texas	956,683	1,014,945	1,405,077	2,073,823	2,469,770	2,593,873
Louisiana		[d] 858,145	[d] 1,747,379	[d] 2,119,948	[d] 2,227,999	[d] 2,163,934
Alabama						
Arkansas						203,728
Colorado						
Wyoming	301,151	295,858	309,816	269,421	214,103	62,398
Montana						
Kentucky	908,293	901,759	1,070,664	1,225,116	1,787,308	1,942,423
California	476,697	800,714	1,134,456	1,883,450	2,910,784	4,069,004
Illinois	[e] 613,642	[e] 687,726	[e] 616,467	[e] 574,015	[e] 437,275	[e] 350,371
Missouri	12,611	10,496	11,576	6,795	5,319	7,731
South Dakota	31,999	16,984	30,412	31,166	27,220	25,809
North Dakota	7,010	5,738				
Michigan	820	1,330	1,470	1,405	1,442	1,510
Tennessee	300	300	375	600	300	400
Iowa	40	70	120	120	200	250
	70,756,158	74,621,534	84,563,957	87,846,677	94,115,524	101,312,381

[a] Includes value of gas piped from West Virginia to Maryland.
[b] Includes value of gas piped from Kansas to Missouri in 1908, 1909, 1914 and 1915 and from Kansas and Oklahoma to Missouri in 1910, 1911, 1912, and 1913.
[c] A portion of this was consumed in Chicago, Ill.
[d] Includes value of gas piped from Louisiana to Texas and Arkansas.
[e] Includes value of gas produced in Illinois and consumed in Vincennes, Ind.

COMBINED VALUE OF NATURAL GAS AND PETROLEUM.

The following table shows the value of natural gas and of petroleum and their combined value in 1914 and 1915, by States, arranged in the order of the value of the combined production:

Value of natural gas and petroleum produced in the United States in 1914 and 1915.

1914.

State.	Natural gas.	Crude petroleum.	Natural gas and crude petroleum.
Oklahoma	$8,050,039	$57,253,187	$65,303,226
West Virginia	35,076,755	18,468,540	53,545,295
California	2,910,784	48,066,096	50,976,880
Pennsylvania	20,839,869	15,573,822	36,413,691
Ohio	14,667,790	13,372,729	28,040,519
Illinois	437,275	25,426,179	25,863,454
Texas	2,469,770	14,942,848	17,412,618
Louisiana	2,227,999	12,886,897	15,114,896
Alabama			
Kansas	3,340,025	2,433,074	5,773,099
New York	2,600,352	1,760,868	4,361,220
Indiana	755,407	1,548,042	2,303,449
Arkansas			
Colorado	214,103	200,894	2,094,189
Wyoming		1,679,192	
Kentucky	490,875	498,556	989,431
South Dakota	27,220		27,220
North Dakota			
Missouri	5,319		
Michigan	1,442	14,291	21,052
Alaska			
Tennessee	300		300
Iowa	200		200
	94,115,524	214,125,215	308,240,739

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Value of naural gas and petroleum produced in the United States in 1914 and 1915—Continued.

1915.

State.	Natural gas.	Crude petroleum.	Natural gas and crude petroleum.
Oklahoma	$9,195,804	$56,706,133	$65,901,937
West Virginia	36,424,263	14,468,278	50,892,541
California	4,069,004	36,558,439	40,627,443
Pennsylvania	21,139,605	12,431,353	33,570,958
Ohio	17,391,060	10,061,493	27,452,553
Illinois	350,371	18,655,850	19,006,221
Texas	2,593,873	13,026,925	15,620,798
Louisiana	2,163,934	10,804,653	12,968,587
Kansas	4,037,011	1,702,891	5,739,902
New York	2,335,252	1,390,325	3,725,577
Wyoming	62,398	2,217,018	2,462,901
Colorado		183,485	
Montana			
Indiana	695,380	813,395	1,508,775
Kentucky	614,998	418,357	1,033,355
Arkansas	203,728		203,728
Alabama			
Missouri	7,731	24,295	33,536
Michigan	1,510		
Alaska			
South Dakota	25,809		25,809
North Dakota			
Tennessee	400		400
Iowa	250		250
	101,312,381	179,462,890	280,775,271

SUMMARY OF WELLS DRILLED.

Wells drilled for natural gas in 1915.

State.	Productive Dec. 31, 1914.	Drilled in 1915.			Abandoned in 1915.	Productive Dec. 31, 1915.
		Gas.	Dry.	Total.		
Alabama	16	1	1	2		17
Arkansas	99	3		3	1	101
California	75	2	2	4	5	72
Colorado	5	1		1		6
Illinois	416	28	67	95	66	378
Indiana	2,224	65	11	76	226	2,063
Iowa	6					6
Kansas	2,261	554	194	748	372	2,443
Kentucky	276	6	1	7	21	261
Louisiana	238	35	10	45	20	253
Michigan	17				5	12
Missouri	60	1	1	2	3	58
Montana	3	2		2		5
New York	2,031	176	50	226	136	2,071
North Dakota	13	2		2	3	12
Ohio	5,809	800	260	1,060	545	6,064
Oklahoma	1,205	209	118	327	185	1,229
Pennsylvania	13,073	863	188	1,051	505	13,431
South Dakota	31	1		1	1	31
Tennessee	7	2	4	6		9
Texas	197	27	30	57	21	203
West Virginia	7,194	779	97	876	355	7,718
Wyoming	35	6	1	7		41
	35,291	3,563	1,035	4,598	2,370	36,484

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ACREAGE CONTROLLED BY NATURAL-GAS PRODUCERS.

Land controlled by natural-gas producers in the United States in 1914 and 1915, in acres.

State.	1914				1915			
	In fee.	Leased.	Gas rights.	Total.	In fee.	Leased.	Gas rights.	Total.
Alabama	85	155,200	.....	155,285	130	156,800	.....	156,930
Arkansas	600	20,918	.....	21,518	500	51,337	.....	51,837
California	2,844	2,412	20,640	25,896	3,042	4,050	20,640	27,732
Colorado	2,326	300	.....	2,626	3,441	2,300	.....	5,741
Illinois	509	180,876	15,943	197,328	282	182,107	24,046	206,435
Indiana	105,899	89,768	508	196,175	85,678	79,182	1,004	165,864
Kansas	28,708	397,932	11,075	437,715	28,017	326,735	11,877	366,629
Kentucky	5,594	160,968	636	167,198	8,161	144,727	.....	152,888
Louisiana	8,430	106,750	10,187	125,367	12,138	221,913	20,474	254,525
Missouri	1,405	.....	.....	1,405	933	.....	.....	933
Montana	1,600	10,000	.....	11,600	920	19,840	.....	20,760
New York	11,571	626,717	5,930	644,218	10,318	530,262	6,703	547,283
Ohio	21,385	1,249,532	90,861	1,361,778	30,090	1,479,234	9,905	1,519,229
Oklahoma	17,275	1,165,485	13,017	1,195,777	19,657	1,224,777	48,258	1,292,692
Pennsylvania	179,929	1,577,889	395,301	2,153,119	178,419	1,619,993	375,991	2,174,403
Tennessee	.....	.....	.....	.....	.....	5,500	.....	5,500
Texas	64,463	636,094	62,030	762,587	14,858	457,955	16,757	489,570
West Virginia	103,636	2,281,117	706,753	3,091,506	124,333	2,399,225	660,687	3,184,245
Wyoming	3,158	20,808	.....	23,966	2,658	21,688	.....	24,346
	559,417	8,682,766	1,332,881	10,575,064	523,575	8,927,625	1,196,342	10,647,542

NATURAL-GAS INDUSTRY BY STATES.

NEW YORK.

PRODUCTION.

The volume of natural gas produced in New York, though important locally, was only about 1.2 per cent of the total volume produced and consumed in the United States in 1915. Much of the gas produced commercially in this State is derived from wells that likewise yield petroleum, and to an appreciable extent the natural-gas output reflects conditions in the local petroleum industry. Throughout the greater part of 1915 activity in the oil districts in New York, as in those of the other States in the Appalachian field, was restricted for the most part to proved territory, as the market price of the highest grade oil averaged too low to warrant the hazards of wildcat drilling. As a consequence of the decreased activity in drilling and of the fact that many of the wells completed were located in areas from which gas had been produced for many years, the total volume of natural gas obtained from the New York fields in 1915 was less than that obtained in 1914.

It is estimated that the volume of gas produced in New York in 1915 amounted to 7,976,985,000 cubic feet and that its total value at the point of consumption was $2,335,252, the average price per thousand cubic feet being 29.27 cents. Compared with corresponding data for 1914, these statistics show decrease, in 1915, of 958,202,000 cubic feet, or 11 per cent in volume, and of $265,100, or 10 per cent, in market value, despite an increase of 0.17 cent in average unit price.

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In Allegany, Steuben, and Cattaraugus counties, where the gas found is generally associated with petroleum, a total of 83 gas wells were completed in 1915. In this area the best results, from the standpoint of the gas producer, were obtained on the Allegheny Indian Reservation, in Cattaraugus County, where a number of wells ranging in initial capacity from 1,500,000 to 2,000,000 cubic feet of gas were drilled in the vicinity of Red House. Wells in this locality range in depth from 900 to 1,300 feet and in rock pressure from an average of 25 pounds to the square inch on old wells to 160 pounds on new ones.

In Chautauqua and Erie counties, where the gas is unaccompanied by petroleum, development work attained its normal proportions, a total of 46 new gas wells being drilled in these two counties during 1915. Farther to the east in Genesee, Wyoming, Livingston, and Monroe counties, where conditions in the petroleum industry are likewise not involved, the usual activity, which is never great, prevailed. In all, 21 new gas wells were completed in these four counties in 1915, of which 9 were credited to the Churchville district, in Monroe County.

In Ontario, Yates, Schuyler, and Chemung counties conditions were essentially unchanged in 1915. Aside from that commercially distributed in the villages of Gorham, West Bloomfield, Bristol, Bristol Center, and Naples, in Ontario County, and in the city of Watkins, in Schuyler County, the gas produced in these four counties is from individual wells, which furnish enough gas for illumination and often for fuel in one or two residences each.

In northern Onondaga County three gas wells were compieted at Baldwinsville, and in northern Oswego Countv five were completed in the Lacona-Sandy Creek district.

With the exception of a small volume transported across the State boundary and consumed in Bradford, Pa., all the gas produced in New York in 1915 was consumed within the State.

CONSUMPTION.

The total volume of natural gas consumed in New York in 1915 is estimated at 18,776,496,000 cubic feet, a gain of 374,666,000 cubic feet, or 2 per cent, over the volume consumed in 1914. Of this quantity 10,952,782,000 cubic feet, or 58 per cent, valued at $3,369,970, was piped from Pennsylvania. The growing dependence of gas consumers in New York on sources outside the State is indicated by the fact that the volume of gas imported in 1915 was 13 per cent greater than that imported in 1914, though the total volume of gas consumed increased only 2 per cent.

The market value of the gas consumed in New York in 1915 is estimated at $5,676,097, the average price per thousand cubic feet to the consumer being 30.23 cents. The explanation of the relatively high average price received for the gas consumed in New York lies in the fact that the greater proportion of it was distributed to domestic consumers.

About 17,309,353,000 cubic feet, or 92 per cent of the gas consumed, was supplied to 153,972 domestic consumers at an average price of 31.19 cents per thousand cubic feet, the remaining 8 per cent being consumed by 346 industrial consumers. Most of the gas con-

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sumed for industrial purposes in New York is used for the generation of power in gas engines or under boilers, only a small quantity being used in furnaces of manufacturing plants.

Record of natural-gas industry in New York, 1898–1915.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1898	62	$229,078	a 68,662	103	$1,006,567	63	9	422
1899	84	294,593	a 76,544	121	1,236,007	36	7	447
1900	89	335,367	a 89,837	138	1,456,286	57	11	504
1901	114	293,232	a 95,161	98	1,694,925	53	14	557
1902	116	346,471	50,536	215	1,723,709	69	8	626
1903	144	493,686	57,935	208	1,944,667	75	11	700
1904	153	522,575	67,208	451	2,222,980	78	12	744
1905	148	623,251	67,848	447	2,434,894	80	17	839
1906	143	672,795	74,538	95	2,654,115	64	14	919
1907	208	766,157	83,805	155	3,098,533	61	13	1,049
1908	215	959,280	91,391	213	3,281,312	68	19	1,211
1909	282	1,222,666	92,958	570	3,286,523	86	18	1,340
1910	273	1,678,720	106,538	717	3,963,572	97	20	1,411
1911	302	1,418,767	116,314	208	4,276,324	167	53	1,531
1912	332	2,343,379	129,980	805	4,866,321	218	54	1,736
1913	366	2,425,633	136,330	639	4,888,412	200	54	1,929
1914	367	2,600,352	146,236	666	5,510,204	178	55	2,031
1915	346	2,335,253	153,972	815	5,676,097	176	50	2,071

a Number of fires supplied.

Depth and rock pressure of wells in New York, 1911–1915.

County.	Depth (feet).	Pressure (pounds).				
		1911	1912	1913	1914	1915
Allegany	600–1,900	15–150	7– 300	7– 250	15–150	10–250
Cattaraugus	400–3,200	1–120	0– 700	0– 500	0–400	5–150
Chautauqua	150–3,250	0–700	0–a 900	0– 700	0–800	0–750
Erie	360–3,200	10–700	25–a 950	42–a 1,000	15–750	30–700
Niagara	550					
Genesee	1,150–1,905	500	500	400	450	500 600
Livingston	345–2,000	100–400	200– 525	200– 400	200–350	150–350
Monroe	440–1,300		50– 400	160– 400	160–205	220
Onondaga	1,000–3,000	300–600	3– 300	400– 600	300	150
Ontario	114–2,400	60–440	55– 450	1– 450	3– 60	50–480
Seneca	1,250–1,550					
Oswego	700–1,700	11–290	8– 75	25– 145	3–300	10–200
Schuyler	1,000–1,800	200–435	300– 435	150– 435	3–435	5–300
Yates	375–1,900					
Steuben	133–1,200		75– 200	75– 400	75–200	75–145
Wyoming	1,100–2,000	125	110– 140	140– 400	250–300	165–210

a New well.

PENNSYLVANIA.

PRODUCTION.

Since the beginning of the petroleum industry near Titusville in 1859 natural gas has been produced in Pennsylvania, though its extensive utilization as a source of light and power did not begin until 1883, when gas from the Murrysville district, Westmoreland County, was first piped to Pittsburgh. As early as 1872 waste gas

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from oil wells was utilized on a small scale in Titusville, Crawford County, and in Karns City, Petrolia, Argyle, and Fairview, Butler County. In 1873 natural gas from a well opposite Leechburg, on the south side of Kiskiminitas River, in Armstrong County, was piped across the river and utilized as a fuel in the iron works of Rogers & Burchfield; and in October, 1875, gas from Butler County was piped to Etna, near Pittsburgh, and employed for a similar purpose in the mill of Spang, Chalfant & Co.

Since 1883 the natural-gas industry has been a steady contributor to the mineral wealth of the State, its annual contributions since 1902 being in excess of $15,000,000, and since 1913 in excess of $20,000,000.

Since 1906, the first year for which an estimate of the quantity of gas produced in Pennsylvania is available, the volume of the production has decreased at an average rate of about 2 per cent a year, the volume of the production in 1915 being less by 24,469,695,000 cubic feet, or about 18 per cent, than the estimated volume of the production in 1906.

The natural-gas fields of Pennsylvania are essentially coincident with the oil fields of the State, being distributed over 23 counties lying west of the Appalachian Mountains and occupying the broad belt of gently folded strata that make up the Allegheny Plateau.

Much of the natural gas produced in Pennsylvania is obtained from wells that also produce petroleum and is termed casing-head gas to distinguish it from that obtained from wells that yield gas only. The casing-head gas derived from oil wells in western Pennsylvania is generally rich in propane and butane, the hydrocarbons of the paraffin series, whose presence renders it suitable in a high degree for the manufacture of gasoline.

The total volume of natural gas produced in Pennsylvania in 1915 is estimated at 113,691,690,000 cubic feet, a gain of 2,946,316,000 cubic feet, or 2.6 per cent, over the estimated volume of the production in 1914. The market value of this production is placed at $21,139,605, representing an average sale price of 18.59 cents a thousand cubic feet. Compared with statistics for 1914 these data indicate an increase of $299,736, or 1.4 per cent, in total market value, but a decrease of 0.21 cent in average unit price.

Compared with the value of the petroleum produced in Pennsylvania in 1915, which was $12,431,353, the value of the gas produced in the same year was greater by $8,708,252, or 41 per cent. With this relation in mind it is not difficult to reconcile an appreciable increase in production of natural gas and a rather abrupt decrease in production of petroleum in Pennsylvania in 1915, despite the relatively close association of natural gas and petroleum in the productive fields.

So important has the natural-gas industry become in Pennsylvania that the search for new sources of gas is no longer dependent on activity in the search for oil. The need for new sources of gas to take the place of the fields whose gas supply is nearly exhausted has gradually supplanted the desire for oil as an incentive for drilling in untested or partly tested territory, and the time is rapidly approaching when the discovery of small pools of oil in western Pennsylvania will be but an incident in the quest for natural gas.

The number of gas wells in service in Pennsylvania at the end of 1915 was 13,431, of which 863 were completed during the year. The

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area held at the end of the year for purposes of gas production was 2,174,403 acres.

No important gas fields were discovered in Pennsylvania in 1915. In July considerable activity resulted from the completion, on the Spiegel farm, near East McKeesport, Versailles Township, Allegheny County, of what was termed "the largest gas well ever struck in Pennsylvania." When completed the well was estimated to have an open-flow capacity of 60,000,000 cubic feet a day. For several days this monster gas well ran wild, but it was eventually shut in by the People's Natural Gas Co., of Pittsburgh, which purchased the output from the local company that drilled the well. Within a month the output of this well had dropped to 4,000,000 cubic feet a day, and within two months the flow was essentially exhausted. Other wells, of which there were a dozen or more, drilled in the vicinity of this gusher proved to be barren or very ordinary producers.

The gas field discovered near Ridgway, Elk County, in February, 1914, was fairly well defined in that year, but furnished a number of creditable producers in 1915. In this district the volume and pressure are reported to be well sustained. Farther north, in McKean County, new gas territory of considerable promise has been opened near Norwich, in Norwich Township. Wells completed here in 1915, at depths of 2,500 to 2,700 feet, are reported to have furnished gas under a closed pressure of 800 pounds to the square inch.

At the end of 1915 there were 1,396 producers of natural gas in Pennsylvania.

Although the quantity of gas produced in Pennsylvania was insufficient for the needs of gas consumers within the State, a considerable volume of gas was piped out of the State to supply consumers in New York, Ohio, and West Virginia. The distribution of Pennsylvania gas in Ohio and West Virginia is to consumers in cities and towns adjacent to the Pennsylvania border who can be supplied more conveniently from Pennsylvania sources than from sources within their own States.

CONSUMPTION.

Although Pennsylvania has been forced within recent years to yield first rank as a producer of natural gas to West Virginia, it still occupies the premier place as a consumer. The iron and steel industry in the vicinity of Pittsburgh requires annually an enormous volume of natural gas in the operation of its blast furnaces, foundries, and rolling mills, and the glass industry of the State provides a market of no mean proportions.

It is estimated that 176,367,235,000 cubic feet of natural gas, valued at $30,087,667, at an average price of 17.06 cents a thousand cubic feet, was consumed in the State of Pennsylvania in 1915. A comparison of these data with corresponding statistics for 1914 shows increases in 1915 of 11,532,693,000 cubic feet, or 7 per cent, in volume and of $1,648,343, or 6 per cent, in total market value, but a decrease of 0.19 cent in average price per thousand.

Of the total volume consumed in 1915 about 51,348,384,000 cubic feet, or 29 per cent, valued at $14,009,226, or 47 per cent of the total market value of all gas consumed in the State, was supplied to domestic consumers at an average price of 27.28 cents a thousand, and

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the remaining 71 per cent of the volume, representing 53 per cent of the value of the gas consumed, was supplied to industrial consumers at an average price of 12.86 cents a thousand.

With regard to the quantity of gas involved, domestic consumption in 1915 exceeded that in 1914 by 1,155,642,000 cubic feet, or only 2 per cent, whereas industrial consumption exceeded that in 1914 by 10,377,051,000 cubic feet, or 9 per cent.

A further analysis of the statistics relating to industrial consumption of natural gas in 1915 shows that 91 per cent of the quantity involved, representing an equivalent percentage of the total value of gas consumed for industrial purposes, was consumed as fuel in manufacturing plants, to which it was supplied at an average price of 13.34 cents a thousand, and that the remaining 9 per cent, sold at an average price of 13.25 cents a thousand, was consumed in the generation of power either directly, as in gas engines, or indirectly, under boilers.

Of the total quantity of natural gas consumed in Pennsylvania in 1915 about 75,981,316,000 cubic feet, valued at $12,850,131, was piped into the State from outside sources, the greater part from West Virginia, but a small quantity from New York, supplied as a matter of convenience to consumers residing on the Pennsylvania side of the State boundary.

Record of natural-gas industry in Pennsylvania, 1898–1915.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1898	232	$6,806,742	[a] 213,410	1,021	$6,064,477	373	74	2,840
1899	281	8,337,210	[a] 232,060	1,236	7,926,970	467	104	3,303
1900	266	10,215,412	[a] 229,730	1,296	9,812,615	513	142	3,776
1901	296	12,688,161	[a] 326,912	1,743	11,785,996	660	143	4,436
1902	379	14,352,183	185,678	2,448	13,942,783	775	232	5,211
1903	414	16,182,834	214,432	2,834	16,060,196	699	126	5,910
1904	414	18,139,914	238,481	2,929	17,205,804	701	174	6,352
1905	351	19,197,336	257,416	2,845	19,237,218	765	168	6,566
1906	309	18,558,245	273,184	3,307	21,085,077	603	153	7,300
1907	344	18,844,156	295,115	3,812	22,917,547	769	180	8,051
1908	[b] 572	19,104,944	307,585	4,577	20,678,161	571	147	[c] 8,831
1909	[b] 777	20,475,207	294,781	5,377	21,639,102	756	166	[c] 9,499
1910	[b] 819	21,057,211	321,430	4,102	23,934,691	857	161	[c] 10,337
1911	[b] 1,067	18,520,796	330,537	4,597	23,940,001	832	224	[c] 10,895
1912	[b] 1,104	18,539,672	345,765	3,442	26,486,302	993	219	[c] 11,543
1913	[b] 1,174	21,693,845	400,823	4,373	28,709,565	1,011	259	[c] 12,438
1914	[b] 1,325	20,839,869	415,644	4,307	28,439,324	998	236	[c] 13,072
1915	[b] 1,396	21,139,605	440,673	4,696	30,087,667	863	188	[c] 12,431

[a] Number of fires supplied.

[b] Includes 216 producers having shallow wells in Erie County for their own domestic consumption in 1908, 311 producers in 1909, 345 producers in 1910, 399 in 1911, and 401 in 1912, 1913, 1914, and 1915.

[c] Includes 350 shallow wells in Erie County in 1908, 429 in 1909, 429 in 1910, 476 in 1911, and 492 in 1912, 1913, 1914, and 1915.

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Depth and rock pressure of wells in Pennsylvania, 1911–1915.

County.	Depth (feet)	Pressure (pounds).									
		1911		1912		1913		1914		1915	
Allegheny	750–3,500	10–	800	10–	500	15–a1,000		10–	700	10–	900
Armstrong	575–3,600	3–	435	5–	900	1–	500	1–	800	3–	500
Beaver	700–2,000			30–	70	30–	510	40–	560	30–	200
Butler	700–3,384	4–	800	2–	700	4–	850	8–	450	8–	a 600
Clarion	600–3,000	5–	900	1–	900	2–	800	0–	700	2–	a 850
Elk	500–3,200	40–	900	60–	840	50–	a 980	60–a1,000		60–	a 900
Crawford	550–1,200	0–	100	2–	100	10–	50	5–	40	25–	80
Erie	300–1,600										
Fayette	1,200–2,772	40–	600	35–	700	35–	700	35–	550		600
Cambria	2,350–2,500										
Forest	500–3,165	6–	150	5–	800	17–	700	25–	600	3–	700
Greene	680–3,600	40–	900	60–	575	39–	750	50–	650	30–	600
Indiana	1,100–1,860						600		500		300
Jefferson	700–3,360	60–1,200		90–1,000		100–	960	15–a1,100		5–	800
McKean	750–3,000	5–	850	1–	950	3–	800	2–	525	7–	900
Mercer	800–1,150	160–	250		190	51–	300	26–	450	150–	450
Lawrence	650– 850										
Potter	750–2,400	35–	500	10–	360	20–	600	50–	385	20–	300
Tioga	700–1,400	13–	350								
Venango	350–2,700	10–	500	15–	200	10–	200	24–	450	15–	400
Warren	500–3,290	3–	200	10–	350	5–	280	5–	300	8–	80
Washington	606–3,304	5–	600	5–	550	5–	400	5–	400	2–	400
Westmoreland	1,350–3,600	60–	250	15–	20	6–a1,000		15–a1,000		1–a1,000	

a New well.

WEST VIRGINIA.

PRODUCTION.

Although the existence of natural gas in West Virginia has been known since the time of the first explorations in the Kanawha Valley, the first use to be made of this fuel in the State, so far as has been ascertained, was in 1841, when it was adopted by William Tompkins as a fuel for evaporating brine in the manufacture of salt, a few miles above Charleston, in the Great Kanawha Valley. Its use for this purpose continued for many years. The first town to be supplied with natural gas from West Virginia sources was Wellsburg, Brooke County, which in 1884 obtained sufficient gas from the Barclay wells, drilled in 1882 and 1883, to furnish "fuel for a paper mill, the waterworks, a machine shop and planing mill, a nail and rolling mill, and some 250 dwellings, besides churches, halls, etc." It was not until the nineties, however, that the magnitude of the natural-gas resources of West Virginia began to be recognized. With the opening of the Big Moses gas field, on Indian Creek, Tyler County, in 1894; of the Cameron field, Marshall County, in 1895; and of the Pinegrove field, Wetzel County, in 1897, the gas industry became thoroughly established, and since 1896 the value of the annual production of natural gas in West Virginia has shown a steady increase. In the decade since 1906, the first year for which an estimate of the volume of natural gas produced in West Virginia is available, the volume of the annual production has more than doubled and its market value has nearly trebled.

The productive gas fields of West Virginia, of which the number is legion, are scattered over 32 counties of the State, which lie west of the Appalachian Mountains, in the maturely dissected Allegheny Plateau province. In this State natural gas is found more abundantly than in Pennsylvania, not only as "wet" gas in association

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with petroleum, but as "dry" gas accumulated under favorable conditions in sandstone or limestone reservoirs that contain no oil.

The volume of natural gas produced in West Virginia in 1915 is estimated at 244,004,159,000 cubic feet, a gain of 7,514,984,000 cubic feet, or 3 per cent, over the estimated production in 1914. The value of this volume of gas at the point of consumption is estimated at $36,424,263, at an average price of 14.93 cents a thousand cubic feet. Compared with 1914 these data show increases of $1,347,508, or 3.7 per cent, in total market value, and of 0.05 cent in average unit price.

Although less by nearly 1,500,000,000 cubic feet than the record production in 1913, the volume produced in 1915 was, with this one exception, greater than that produced in any other year in the history of the local industry. The market value of the output in 1915 was greater than that of the production in any preceding year without exception.

The year 1915 is the seventh consecutive year in which West Virginia has led the gas-producing States of this country in volume and the sixth in which it has led in value of natural gas produced. Of the total volume of gas produced in the United States in 1915 West Virginia supplied approximately 39 per cent; of the total value of that production, West Virginia is credited with 36 per cent. The value of the gas produced in West Virginia in 1915 exceeded the value of the State's production of petroleum in that year by $21,955,985, or 152 per cent.

The most prolific sources of natural gas in West Virginia are in Lewis, Harrison, and Ritchie counties, where there are many wells of large volume, in which the pressure shows but little decline from year to year.

Field activity in the quest of natural gas in West Virginia was normal in 1915 but resulted in the discovery of no important areas of new production. Of 876 wells drilled for gas 779, or 89 per cent, were successful, a condition which indicates clearly that so far there is no scarcity of productive gas territory in the State. At the end of 1915 there were 7,718 wells in West Virginia from which natural gas was being produced and utilized.

The total area owned and leased and on which gas rights are held by natural-gas producers in West Virginia amounted to 3,184,245 acres at the end of 1915, an increase of 92,739 acres over the area so held at the end of 1914.

CONSUMPTION.

Although first in rank as a gas-producing State, West Virginia ranks third as a consumer of natural gas. The volume of gas consumed in West Virginia in 1915 is estimated at 94,976,705,000 cubic feet, constituting only about 39 per cent of the year's production. The average price paid by the consumer of gas in this State in 1915 was 7.85 cents a thousand cubic feet, and the total market value of the gas consumed was $7,451,003. Compared with corresponding data for 1914 these statistics show a decrease of 170,542,000 cubic feet, or about 0.2 per cent, in volume of gas consumed, but an increase of $116,313, or 1.6 per cent, in total market value, due to an increase of 0.14 cent in average unit price. The decrease in volume is accounted for by the lack of drilling activity in the oil fields of the State occasioned by an abnormally low average market price for petroleum during much of the year. The relative increase in market

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value is due primarily, of course, to an increase in the average price paid by the consumer, but secondarily to the fact that a larger proportion of the total gas distributed was sold at the domestic rate in 1915 than in 1914.

Of the total volume of gas consumed about 17,893,105,000 cubic feet, or 19 per cent, valued at $3,281,532, was distributed to domestic consumers at an average price of 18.34 cents a thousand, and the remaining 81 per cent, valued at $4,169,471, was distributed to industrial consumers at an average price of 5.41 cents a thousand.

A comparison of these statistics with corresponding items relating to the consumption of natural gas in West Virginia in 1914 shows increases of 5 per cent in volume and of 3 per cent in market value, but a decrease of 0.3 cent in average unit price of natural gas distributed to domestic consumers; also a decrease of 1.3 per cent in volume, but increases of 0.5 per cent in market value and of 0.08 cent in average unit price of gas distributed to industrial consumers.

One industry that is almost entirely confined to West Virginia is the manufacture of carbon black, for which a large supply of gas that can be obtained at a low price is requisite. It is estimated that 18,988,070,000 cubic feet of natural gas, valued at $445,455, an average of 2.34 cents a thousand, was used by carbon-black factories in West Virginia in 1915. It is estimated that from the burning of this volume of gas 17,262,000 pounds of carbon black was recovered.

Of the total volume of natural gas produced in West Virginia in 1915 about 92,135,038,000 cubic feet was consumed within the State in that year, the remaining 151,869,121,000 cubic feet, valued at $29,583,792, being marketed in Pennsylvania, Ohio, Indiana, and Kentucky. Of the total quantity of natural gas consumed in this State in 1915 a small proportion was imported from Pennsylvania and Ohio to supply consumers adjacent to the State boundaries. The statistics of natural-gas consumption in West Virginia include a relatively small volume of natural gas exported to a few towns in western Maryland.

Record of natural-gas industry in West Virginia, 1898–1915.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1898	19	$1,334,023	[a]28,652	125	$914,969	32	4	227
1899	30	2,335,864	[a]38,137	305	1,310,675	78	6	300
1900	34	2,959,032	[a]45,943	184	1,530,378	129	6	428
1901	44	3,954,472	[a]55,808	266	2,244,758	177	8	604
1902	79	5,390,181	29,357	877	2,473,174	142	37	745
1903	88	6,882,359	36,179	1,122	3,125,061	242	43	987
1904	90	8,114,249	44,563	1,005	3,388,515	292	38	1,274
1905	76	10,075,804	45,588	1,417	3,596,608	386	28	1,679
1906	67	13,735,343	51,281	913	3,720,440	263	23	1,831
1907	105	16,670,962	58,807	1,000	[b]3,757,977	377	59	2,169
1908	138	14,837,130	63,228	1,225	[b]4,020,282	441	80	2,511
1909	183	17,538,565	70,853	1,907	[b]5,183,054	801	65	3,232
1910	241	23,816,553	86,778	2,659	[b]5,617,910	1,002	69	4,052
1911	340	28,435,907	87,438	1,566	[b]3,240,152	905	117	4,790
1912	406	33,324,475	94,273	1,953	[b]7,001,331	870	149	5,533
1913	451	34,164,850	101,234	1,834	[b]7,333,956	1,038	128	6,534
1914	475	35,076,755	106,277	1,850	[b]7,334,690	856	154	7,194
1915	506	36,424,263	115,908	1,910	[b]7,451,003	779	97	7,718

[a] Number of fires supplied. [b] Includes gas consumed in Maryland.

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Depth and rock pressure of wells in West Virginia, 1911–1915.

County.	Depth (feet).	Pressure (pounds).				
		1911	1912	1913	1914	1915
Boone	1,060–3,900	.....	350– 520	400– 525	130– 550	200– 600
Braxton	1,200–3,000	840	.....	.....	400	800
Clay	1,400–2,100	200– 400	300– 600	200– 450	300– 500	250– 400
Taylor	1,453–2,800	80– 800	100– 600	400– 1,000	110– 800	135– 800
Brooke	1,200–1,950	0– 50	0– 270	0– 640	0– 180	0– 80
Cabell	900–2,800	250– 500	350– 400	350– 500	400	400
Calhoun	824–4,000	35– 655	20– 760	60– 400	10–a1,200	20– 650
Doddridge	1,400–3,100	100– 750	5– 760	75– 900	50– 465	50– 400
Gilmer	1,148–3,181	640	130– 210	100– 180	100– 600	112– 700
Hancock	700–1,880	1– 60	20– 150	40– 100	20– 75	30
Harrison	800–3,300	50–1,040	40– 900	50– 900	100– 900	70– 800
Kanawha	715–2,585	400– 500	250– 600	50– 500	225– 500	210– 480
Lewis	1,127–3,000	60– 950	45–a1,100	50–a1,100	20–a1,000	80–a900
Lincoln	900–2,720	400– 650	200– 600	400– 560	300– 540	220– 500
Logan	1,150–2,200	.....	550– 560	75– 540	75– 540	400– 450
Marion	1,280–3,478	90–1,200	75– 805	40– 500	75– 600	30–a925
Marshall	1,000–2,927	50– 300	6– 300	125– 300	110– 300	110– 150
Mingo	1,800–2,600	300– 600	375– 550	250– 600	200– 500	425– 580
Wayne	1,309–1,650					
Monongalia	1,300–3,500	60– 700	60– 825	60– 820	60– 800	37– 725
Nicholas	1,200–1,300					
Ohio	1,500–2,000	40– 125	15– 350	25– 350	15– 350	15– 525
Pocahontas	2,000–2,500					
Pleasants	900–2,150	150– 400	50– 300	30– 500	30– 250	125– 375
Putnam	900–2,400	300– 800	.....	.....	.....	.....
Upshur	1,928–2,800	25– 740	480– 600	480	350– 380	240
Ritchie	725–2,925	250– 275	20– 700	30– 700	20– 600	20– 500
			320– 465	350– 750	240– 600	175– 500
Roane	1,472–2,600					
Tyler	1,400–3,400	50– 100	50– 750	50– 650	150– 685	10– 500
Wetzel	1,300–3,560	0– 200	50– 113	5– 150	5– 150	50– 130
Wirt	500–1,875	10– 450	30– 500	18– 275	70– 125	30– 150
Wood	1,030–1,900	160– 350	300– 520	150– 500	198– 400	40– 460

a New well.

OHIO.

PRODUCTION.

It is estimated that the volume of natural gas produced in Ohio in 1915 amounted to 79,510,032,000 cubic feet and that its total market value was $17,391,060, or 21.87 cents a thousand cubic feet. Compared with data relating to natural gas produced in Ohio in 1914 these statistics show increases of 11,239,858,000 cubic feet, or 16 per cent, in volume of gas produced; of $2,723,270, or 18 per cent, in total market value; and of 0.39 cent in average market price.

Both the quantity and the value of the natural gas produced in Ohio in 1915 constitute new records for the gas industry of this State, as they exceed by substantial margins the corresponding totals for any previous year. This State ranked fourth in production of natural gas in 1915.

Natural gas has been known to exist in Ohio since the earliest settlement of the State, its presence having been noted in many localities where it was found in cellars, wells, springs, and rock crevices. Explosions of natural gas in excavations for various purposes have been by no means infrequent. The first recorded use to be made of natural gas in Ohio was in 1838, when gas from a water well was employed as a fuel in the residence of Daniel Foster, in Findlay, Hancock County.

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In 1860 natural gas, discovered in the course of drilling for oil in the neighborhood of East Liverpool, Columbiana County, was utilized in the manufacture of salt at that place. In October, 1873, Homer Laughlin sunk a well within the town limits, this being the first well drilled specifically for natural gas in the State. Its product was also the first gas utilized in the East Liverpool district for domestic purposes.

In 1884, when the United States Geological Survey began to collect statistics of the natural-gas industry, natural gas from local sources was being utilized at Cleveland, Steubenville, and Wooster, in addition to the localities already mentioned.

Inspired by the success of the industry in Pennsylvania, the Findlay Natural Gas Co. began an earnest quest for natural gas at Findlay in 1884, and in November of that year gas in commercial quantities was struck in the "Trenton" limestone at a depth of 1,100 feet. Although the flow from this well was not great, it was sufficient to stimulate the search for gas in that locality, which resulted in the drilling of the famous Karg well in January, 1886, and in the permanent establishment of the natural-gas industry in Ohio. Since 1904 the value of the natural-gas produced in Ohio has been in excess of $5,000,000 annually and since 1911 it has been in excess of $10,000,000 annually.

The natural-gas fields of Ohio are scattered over 50 counties lying mainly in the eastern half and the northwestern quarter of the State. The principal gas field, generally referred to as the central Ohio gas belt, lies a little east of the center of the State and extends from the northern part of Vinton County on the south to Lake Erie on the north, with an average width of about 25 miles. The continuity of this field is broken, however, by unproductive areas in southern Ashland and northern Knox counties and in southern Lorain and northern Ashland counties.

Throughout the oil fields of southeastern Ohio and of the Lima division of the Lima-Indiana field, in northwestern Ohio, natural gas is found in considerable quantities in association with petroleum.

Natural gas from oil wells in the southeastern part of the State forms the basis for a thriving casing head gasoline industry in Monroe, Jefferson, Columbiana, and Washington counties.

In northeastern Ohio shallow wells penetrating the black Ohio shale of the Devonian system yield small but persistent flows of natural gas, sufficient in the case of individual wells to supply light and often fuel for one or two families.

Activity in the quest for natural gas in Ohio in 1915 was centered in the area adjacent to Cleveland, Cuyahoga County, which came into prominence in 1914, following discoveries of gas in fair volume and under high pressure late in 1913. Of 469 wells drilled in 1915 for gas in this district, 412, or 88 per cent, were successful. There were 147 exhausted wells abandoned in this district in 1915, and at the end of the year the active gas wells numbered 626. Drilling on lots within the city limits, which constituted so objectionable a feature of operations in this area in 1914, gradually subsided with the exhaustion of productive territory there, and activity was trans-

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ferred to points west and southwest of the city, where acreage tracts were available for development, as the field was proved to extend in that direction.

Incidental to the gas development petroleum was found in commercial quantities in a few of the wells. The greater proportion of the gas obtained in this field is from the Clinton sand of the Silurian system, reached at depths of 2,750 to 3,000 feet, although some production is obtained from the Newburg sand, encountered at depths of 2,450 to 2,600 feet. This field is fully described in a forthcoming report by G. S. Rogers, of the United States Geological Survey.

CONSUMPTION.

Although Ohio takes fourth rank as a producer of natural gas, it is superseded only by Pennsylvania as a consumer. It is estimated that in 1915 a volume of 146,724,989,000 cubic feet, valued at $31,900,764, or an average of 21.74 cents a thousand, was consumed in Ohio. A comparison of these data with corresponding statistics for 1914 shows increases of 6 per cent in volume, of 6.5 per cent in total market value, and of 0.11 cent in average unit price.

Of the total volume of gas consumed in Ohio in 1915 about 77,087,545,000 cubic feet, or 52 per cent, valued at $22,626,560, or 71 per cent of the total value, was distributed to 773,548 domestic consumers at an average price of 29.35 cents a thousand cubic feet, and the remaining 48 per cent, representing 29 per cent of the total value, was distributed to 2,499 industrial consumers at an average price of 13.32 cents a thousand.

Compared with 1914, these statistics show, with regard to domestic consumption, increases in 1915 of 7 per cent in volume, of 8 per cent in market value, of 5.4 per cent in the number of consumers, and of 0.24 cent in average unit price, and, with regard to industrial consumption, increases in 1915 of 4.6 per cent in volume, of 3 per cent in market value, and of 10 per cent in the number of consumers, and a decrease of only 0.23 cent in average unit price.

Of the natural gas produced in Ohio in 1915 practically all was consumed within the State, a small volume, in the aggregate, being piped into contiguous parts of West Virginia and of Indiana to supply consumers adjacent to the State boundaries. Of the total volume of natural gas consumed in Ohio in 1915 about 68,186,364,000 cubic feet, valued at $14,729,341, was piped into the State from West Virginia, Pennsylvania, and Indiana, the greatest proportion coming from West Virginia.

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Record of natural-gas industry in Ohio, 1898–1915.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1898	237	$1,488,308	[a]68,211	349	$2,250,706	120	12	806
1899	359	1,860,271	[a]77,737	691	3,207,286	134	17	929
1900	281	2,178,234	[a]135,743	1,092	3,823,209	97	19	990
1901	305	2,147,215	[a]149,709	949	4,119,059	113	35	1,099
1902	451	2,356,458	120,127	786	4,785,766	266	40	1,343
1903	515	4,479,040	197,710	1,786	7,200,867	290	62	1,523
1904	453	5,315,564	232,557	1,136	9,393,843	324	49	1,661
1905	425	5,721,462	274,585	2,955	10,396,683	342	58	1,705
1906	409	7,145,809	310,175	3,316	12,652,520	337	51	[b]1,977
1907	468	8,718,562	380,489	5,476	15,227,780	431	90	2,942
1908	[c]970	8,244,835	427,276	3,621	15,166,434	398	124	[d]3,691
1909	[c]1,534	9,966,938	450,973	5,260	18,884,312	548	149	[d]4,260
1910	[c]1,630	8,623,954	475,505	3,187	21,210,965	466	202	[d]4,717
1911	[c]1,900	9,367,347	577,263	3,634	22,792,270	450	191	[d]4,999
1912	[c]2,031	11,891,299	641,724	4,414	27,196,162	637	289	[d]5,163
1913	[c]2,056	10,521,930	685,956	5,010	27,055,824	408	235	[d]5,308
1914	[c]2,268	14,667,790	734,354	6,102	29,936,642	686	257	[d]5,809
1915	[c]2,499	17,391,060	773,548	5,621	31,900,764	800	260	[d]6,064

[a] Number of fires supplied.
[b] Exclusive of complete report of shallow wells.
[c] Includes 735 producers in Ashtabula, Erie, Huron, Lake, Lorain, and Cuyahoga counties having shallow wells for their own domestic purposes in 1908, 1,239 in 1909, 1,289 in 1910, 1,476 in 1911, 1,579 in 1912, 1,600 in 1913, and 1,561 in 1914 and 1915.
[d] Includes 901 shallow wells located in Ashtabula, Erie, Huron, Lake, Lorain, and Cuyahoga counties in 1908, 1,568 in 1909, 1,541 in 1910, 1,757 in 1911, 1,773 in 1912, 1,778 in 1913, and 1,733 in 1914 and 1915.

Depth and rock pressure of wells in Ohio, 1911–1915.

County.	Depth (feet).	Pressure (pounds).									
		1911		1912		1913		1914		1915	
Allen	1,200–1,470										
Ashland	2,500–2,900		670	250–	650	90–	500	105–	300	80–	500
Ashtabula	400–2,200	0–	275	0–	410			30–	250	20–	[a]670
Athens	440–1,500	25–	350	10–	350	50–	350	10–	170	30–	170
Auglaize	1,100–1,300	2–	90	5–	110	3–	140	7–	70	5–	
Belmont	778–2,000	40–	150	20–	50	60–	140		125	110–	125
Carroll	500–1,434	90–	300	100–	150	90–	150				
Clinton	715–	160–	190		160		95		160		90
Columbiana	500–2,000	25–	240	25–	350	16–	300	16–	350	25–	300
Cuyahoga	337–3,200	0–	97	0–	[a]800	0–	[a]1,000	0–	[a]1,200	0–	[a]1,100
Darke	850–1,300	2–	250	2–	300	2–	200	2–	250	2–	300
Erie	350– 650	20–	40	18–	40						
Fairfield	213–2,800	40–	500	40–	350	16–	320	25–	325	25–	150
Guernsey	700–1,500	250–	400		250		300		300	30–	400
Muskingum	800–3,350										
Hancock	800–1,800	0–	200	2–	400	2–	150	1–	200	1–	[a]400
Hardin	1,200–1,650	25–	300	75–	300	20–	300	20–	350	15–	425
Harrison	400–1,650	10–	110	10–	150	5–	225	8–	300	18–	200
Hocking	750–3,300								430		300
Huron	400– 800	10–	25	0–	40						
Holmes	600–1,160	135–	220	100–	170	80–	165	80–	165	80–	180
Jefferson	600–2,026	0–	400	12–	[a]890	15–	300	20–	250	15–	150
Knox	590–3,200	50–	250	15–	250	50–	300	75–	260	75–	300
Lake	360–1,700	0–	165	0–	185						
Lawrence	1,600–1,834						750		425	500–	600
Licking	1,950–3,000	60–	700	80–	400	30–	450	30–	[a]440	40–	[a]625
Logan	1,250–1,500			20–	180		160	30–	120	125–	200
Lorain	338–2,590	0–	[a]150	0–	[a]900	0–	675	0–	150	0–	54
Lucas	700–1,550	5–	100	7–	30	9–	30	5–	39	8–	35
Mahoning	515–2,000				[a]160	150–	158	70–	187	85–	187
Medina	185–3,000	5–	875	4–	[a]1,100	2–	500	3–	300	2–	50
Meigs	600–2,000										
Mercer	1,020–1,400	3–	120	1–	100	1–	105	5–	75	4–	180

[a] New well.

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Depth and rock pressure of wells in Ohio, 1911–1915—Continued.

County.	Depth (feet).	Pressure (pounds).									
		1911		1912		1913		1914		1915	
Monroe	650–2,400	100–	400	8–	200	3–	100	20–	350	20–	160
Morgan	240–1,650	20–	450	20–	450	15–	450	20–	350	40–	500
Noble	484–2,000	200–	650	100–	620	150–	620	40–	380	40–	450
Ottawa	1,200–2,000	85–	450	40–	450	30–	350	125–	350	30–	450
Perry	650–3,620	50–	250	150–	800	150–	600	50–	80		
Richland	1,950–2,800	150–	300	200–	250						
Sandusky	440–1,451	5–	165	5–	160	5–	150	10–	160	1–	150
Sciota	1,535										
Seneca	370–1,760	25–	140	20–	110	20–	140	20–	100	70–	90
Summit	900–3,550		160	[a]980–	1,020						
Trumbull	370– 388						10		10		
Tuscarawas	850–5,050	260–	325	180–	350	160–	475		120	78–	400
Van Wert	1,200–1,285		40		40						
Vinton and Jackson	520–2,707										
Warren	275–1,000										
Wayne	1,150–3,500				[a]800	300–	[a]1,120	200–	850	100–	[a]900
Washington	500–2,600	15–	500	15–	600	15–	500	10–	740	15–	400
Wood	1,170–1,500	10–	15	10–	12	10–	15	10–	35	10–	40

[a] New well.

KENTUCKY.

PRODUCTION.

As a commercial enterprise the production of natural gas in Kentucky is restricted to one or two localities in each of the following counties: Breckinridge, Clay, Floyd, Hardin, Knox, Magoffin, Martin, Menifee, Morgan, Muhlenberg, Logan, and Wayne. Individual wells, from which sufficient gas is obtained to supply fuel for drilling purposes or fuel and illumination for isolated residences, are to be found in Allen, Barren, Boyd, Bracken, Christian, Jefferson, Lawrence, McCreary, Meade, and Powell counties.

It is estimated that from these widely separated sources a total of 1,667,423,000 cubic feet of natural gas was produced and utilized in 1915. This volume exceeds that produced in 1914 by 245,605,000 cubic feet, or 17 per cent, and indicates a growing appreciation of the benefits that may be derived from the development of relatively small supplies of this ideal fuel.

The market value of this production is estimated at $614,998, an average of 36.88 cents a thousand cubic feet at the point of consumption.

Little change is noted from year to year in the natural-gas industry in Kentucky, the annual fluctuations in volume of production reflecting with fair accuracy the degree of activity in drilling in the productive oil fields of the State.

The principal source of gas in Kentucky is the Menifee gas field, in Menifee County, from which gas is piped to Lexington, Winchester, and Mount Sterling, by the Central Kentucky Natural Gas Co.; to Clintonville and North Middletown by the Blue Grass Natural Gas Co.; to Paintsville by the Johnson County Natural Gas Co.; and to Paris by the Paris Gas & Electric Co.

From the oil fields of Morgan County sufficient gas is obtained to supply consumers in West Liberty and Cannel City.

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In Muhlenberg County a number of wells less than 500 feet deep yield a volume of gas ample for the needs of domestic consumers in Central City, who are served by the Central City Gas Co. Although the wells in this field are shallow, the rock pressure, which ranges from 65 to 185 pounds to the square inch declines slowly. Wells drilled by S. F. Gish in Logan County in 1915 disclosed the presence of natural gas in quantities adequate for commercial exploitation, and mains were laid to Lewisburg before the end of the year, though gas was not distributed there until 1916. Steps were taken toward the extension of service from this field to Dunmoor and Russellville in the early part of 1916.

In Magoffin County a few shallow gas wells on Burning Fork of Licking River supply fuel and illuminant to nearly 100 domestic consumers in Salyersville.

Consumers in Barboursville are supplied with gas by the Cumberland Natural Gas Co., which obtains its supply from a single well in Knox County. Wells in Martin County contribute to the gas supply distributed by the United Fuel Gas Co. in Ashland, Catlettsburg, and adjacent towns. In Wayne County considerable gas is utilized as fuel in the oil fields, and enough more is produced to supply consumers in Hazel Green and to operate a gasoline plant installed during 1915 by the Wood Oil Co.

Six wells in Cloverport, Breckenridge County, supply gas for domestic use by about 100 consumers in that town, and one well in Clay County supplies the domestic requirements of about 25 consumers in Burning Springs. Five wells in Hardin County supply the gas consumed in the town of West Point, and several other wells in this county furnish enough gas for heating and lighting from one to four residences each.

The mining town of Wayland is supplied by the Elk Horn Coal Corporation with gas from five wells in Floyd County.

There were 86 producers of natural gas in Kentucky in 1915, and at the end of the year gas was being produced and utilized from 261 wells in this State. The total area held for gas development at the end of 1915 was 152,888 acres, of which 8,161 acres were held in fee.

CONSUMPTION.

The volume of natural gas consumed in Kentucky in 1915, amounting to about 7,746,353,000 cubic feet, was greater by 520,727,000 cubic feet, or 7 per cent, than that consumed in 1914, which constituted the record for gas consumption in this State prior to 1915.

In addition to consuming its entire output of natural gas, Kentucky used, in 1915, 6,078,930,000 cubic feet of gas, valued at $1,327,425, that was piped from West Virginia. Compared with 1914, the volume of gas imported from West Virginia in 1915 was greater by 275,122,000 cubic feet, or nearly 5 per cent.

As the greater part of the natural gas distributed in Kentucky is supplied to domestic consumers, the market value of the volume consumed is relatively high. The total value of the gas consumed in 1915 is estimated at $1,942,423, or an average price to consumers of 25.08 cents a thousand cubic feet. Compared with statistics for

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1914, these data show increases of $155,115, or 8.6 per cent in market value, and of 0.35 cent in average unit price.

Of the total volume of gas consumed in Kentucky in 1915 about 64 per cent was distributed to 84,666 domestic consumers at an average price of 34.19 cents a thousand, and 36 per cent was distributed to 86 industrial consumers at an average price of 9.18 cents a thousand. Compared with 1914, the volume of gas consumed for domestic purposes in 1915 was greater by 17 per cent, whereas the volume consumed for industrial purposes was less by 6 per cent. With increasing imports of natural gas a decline in the volume consumed for industrial purposes is inevitable, as the cost of long-distance transportation is too great to allow the sale of more than small quantities of the gas transported at prices that the industrial consumer can afford to pay.

Natural gas from West Virginia sources is now supplied wholly or in part to consumers in Bellevue, Dayton, Ludlow, West Covington, Covington, Newport, Maysville, Cold Springs, Dover, Foster, Ashland, Catlettsburg, Buchanan, Chinnville, Greenup, Inez, Kavanaugh, Kinner, Louisa, Pollard, Russell, Warfield, Worthington, Lexington, Winchester, Mount Sterling, Ashland, and Louisville.

Record of natural-gas industry in Kentucky, 1906–1915

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	45	$287,501	17,216	18	$287,501	.....	.....	166
1907	38	380,176	19,279	239	380,176	31	14	179
1908	38	424,271	21,778	42	424,271	19	23	218
1909	38	485,192	25,639	137	695,577	26	7	212
1910	47	456,293	27,961	112	908,293	23	12	241
1911	74	407,689	41,201	70	901,759	19	8	255
1912	88	522,455	45,603	103	1,070,664	22	27	267
1913	98	509,846	54,446	146	1,225,116	23	7	274
1914	101	490,875	78,505	128	1,787,308	10	1	276
1915	86	614,998	84,666	117	1,942,423	6	1	261

TENNESSEE.

The natural-gas industry in Tennessee, which has never been important, expanded slightly in 1915 as a consequence of the activity in the search for oil in Scott and Fentress counties. Near Riverton, in Fentress County, one gas well was completed by the Riverton Development Co., and near Oneida, in Scott County, sufficient gas was obtained from one well drilled by the Oneida Oil & Gas Co. to provide fuel for additional drilling and to heat and light four dwellings.

The only other locality in Tennessee where gas was utilized in 1915 was in Franklin County, where two wells supplied gas for domestic consumption in the residences of their owners.

In Perry County inflammable gas, not utilized, accompanies the water in a well 127 feet deep, drilled by J. A. Truce on Bee Creek, near the town of Pope.

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ALABAMA.

The natural-gas industry in Alabama is of little consequence. In 1915 natural gas in sufficient quantities to supply the needs of 291 consumers in the town of Fayette was obtained from three wells in the Fayette gas field, Fayette County, and enough for the needs of 150 consumers in the town of Jasper was obtained from two wells in Walker County. In the Fayette field the wells range in depth from 1,400 to 1,440 feet. In the Walker County field gas is obtained at a depth of 1,800 feet. One gas well was drilled in the Fayette field in 1915.

The statistics of production and consumption of natural gas in Alabama in 1915 are included with those of Arkansas in order to avoid revealing data furnished to the Survey in confidence.

MICHIGAN.

The natural-gas industry in Michigan is of slight importance. Aside from a small quantity of gas obtained from oil wells and utilized in field operations in St. Clair County, the natural gas produced in Michigan is obtained from a few shallow wells in Benzie, Macomb, and Wayne counties, which yield enough gas for lighting one or two residences each.

No new gas wells were drilled in Michigan in 1915, and at the end of the year there were 12 wells producing gas in the State. Four wells that furnished gas in 1914 were abandoned in 1915. The total value of the gas produced in 1915 is estimated at $1,510.

INDIANA.

PRODUCTION.

As a contributor to the natural-gas supply in the United States, Indiana is relatively unimportant, its rank among the States in which gas was produced in 1915 being eleventh in volume and tenth in market value of the product. For many years there has been a steady annual decline in the volume of gas derived from fields within the State, and during the last three years there has been a corresponding increase in the volume of gas piped from outside sources. This condition was not altered in 1915.

The quantity of gas produced in Indiana in 1915 is estimated at 2,260,733,000 cubic feet, a volume less by 318,942,000 cubic feet, or 12 per cent, than the output in 1914.

Natural gas in Indiana is closely associated with petroleum. The gas fields of the State are coextensive with its oil fields, and the small quantity and low pressure of the gas obtained are but a reflection of the advanced stage of exhaustion of the petroleum.

Natural gas was produced in 29 counties in Indiana in 1915—in 16 of them on a commercial scale. In each of these counties a considerable volume of gas is produced from individual wells whose yield, though too small for commercial exploitation, is ample for the needs of one or two families.

With the exception of a small quantity piped across the State boundary to Union City, Ohio, all the gas produced in Indiana in 1915 was consumed within the State.

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The natural gas produced in Indiana in 1915 was supplied by 999 producers from 2,063 wells, 65 of which were completed during the year.

CONSUMPTION.

The quantity of natural gas consumed in Indiana in 1915 is estimated at 4,519,244,000 cubic feet, valued at $1,542,604, the average price per thousand cubic feet being 34.13 cents. Compared with the statistics of gas consumed in 1914 these data show gains of 76,000,000 cubic feet, or 2 per cent, in volume; of $119,724, or 8 per cent, in total value; and of 2.11 cents in average unit price.

The increase in volume is due to a greater utilization of natural gas piped from West Virginia, whereas the increases in market value and price are accounted for in part by the fact that a greater percentage of the total consumption in 1915 was supplied to domestic consumers than in 1914 and in part by the increased prices charged in 1915 for both domestic and industrial service.

It is estimated that in 1915 a total of 3,505,354,000 cubic feet of gas, or 78 per cent of the total volume of gas consumed, was supplied to 44,012 domestic consumers at an average price of 35.89 cents a thousand cubic feet, and that the remaining 1,013,890,000 cubic feet, valued at $284,585, was distributed to 438 industrial consumers at an average price of 28.07 cents a thousand. In 1914 the gas supplied for domestic purposes constituted 76 per cent of the total volume consumed, and unit prices averaged lower by 2.13 cents for domestic service and by 1.67 cents for industrial service than in 1915.

In addition to consuming all the gas produced within its borders, except as already noted, Indiana consumed approximately 2,256,665,000 cubic feet of gas, valued at $846,814, that was piped from West Virginia, as well as a small quantity piped from Ohio.

Record of natural-gas industry in Indiana, 1898–1915.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1898	533	$5,060,969	[a] 173,454	1,867	$4,682,401	706	111	3,325
1899	571	6,680,370	[a] 181,440	1,741	[b] 5,833,370	838	109	3,909
1900	670	7,254,539	[a] 181,751	2,751	[b] 6,412,307	861	156	4,546
1901	656	6,954,566	[a] 153,869	2,570	[b] 6,276,119	985	208	4,572
1902	929	7,081,344	101,481	3,282	[b] 6,710,080	1,331	205	5,320
1903	924	6,098,364	90,118	1,020	[b] 5,915,367	895	242	5,514
1904	846	4,342,409	84,862	390	[b] 4,282,409	706	153	4,684
1905	740	3,094,134	63,194	231	[b] 3,056,634	252	74	3,650
1906	578	1,750,715	47,368	156	[b] 1,750,755	159	46	3,523
1907	687	1,572,605	46,210	218	[b] 1,570,605	185	56	3,398
1908	823	1,312,507	42,054	216	[b] 1,312,507	187	41	3,226
1909	1,010	1,616,903	40,565	369	[b] 1,616,903	190	70	2,988
1910	1,027	1,473,403	36,054	282	[b] 1,473,403	69	33	2,955
1911	1,094	1,192,418	31,576	143	[b] 1,192,418	110	32	2,744
1912	1,140	1,014,295	27,165	140	[b] 1,014,295	96	39	2,547
1913	1,100	843,047	39,776	239	[b] 948,278	69	24	2,370
1914	1,029	755,407	43,410	344	[b] 1,422,880	68	19	2,224
1915	999	695,380	44,012	438	[b] 1,542,604	65	11	2,063

[a] Number of fires supplied. [b] Includes value of gas consumed in Chicago, Ill.

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Depth and rock pressure of wells in Indiana, 1911–1915.

County.	Depth (feet).	Pressure (pounds).				
		1911	1912	1913	1914	1915
Adams	1,000–1,050	.....	100	40 – 50	6	10
Bartholomew	864– 990	150–175	75–125	85–165	80–150	75–160
Blackford	850–1,100	0– 80	0– 12	0– 8	0– 20	0– 7
Clark	128– 244	.....	27	.....	.....	.....
Daviess, Martin	300– 600	9–160	7–150	5–165	25– 40	30– 40
Decatur	700–1,200	0–325	5–330	5–350	5–350	10–315
Delaware	728–1,500	0– 75	0– 60	0– 50	0– 60	0–75
Franklin	728– 730	.....	.....	60	.....	.....
Grant	830–1,200	0–180	2–180	5–200	0– 50	0–100
Hamilton	800–1,280	15–225	8–235	8–225	0–230	0–235
Hancock	700–1,100	3–280	5– 80	8–125	6– 80	6– 60
Harrison	320–1,050	60–110	112	50	50	0– 45
Henry	800–1,200	0– 80	0–100	5–150	4–100	5– 50
Howard	800–1,100	20–250	10–180	35–200	30–160	80–200
Jay	900–1,600	0–110	0–220	0– 50	0– 40	0– 50
Jefferson	1,300–1,360	10	.....	20	.....	.....
Madison	800–1,200	0–180	1–175	0–175	0–100	0– 80
Miami	900–1,000	.....	.....	.....	.....	.....
Marion, Ripley	880–1,050	180–285	150–250	100–160	70–360	100–200
Pike	1,000–1,400	100–480	60–300	25–450	50–225	40– 50
Randolph	900–1,300	2–300	4–140	2–190	1–125	5–100
Rush	700–1,400	0–300	12–300	10–300	15–325	5–300
Shelby	650–1,020	1–300	10–366	15–300	20–300	8–300
Spencer	1,025	.....	410	.....	.....	.....
Sullivan	698– 795	50–100	40–110	30– 50	50–185	.....
Tipton	750–1,100	15–190	3–180	5–125	3–100	2–100
Wayne	800–1,150	25–150	25– 70	45– 75	45	.....

ILLINOIS.

PRODUCTION.

The steady decrease in the volume of gas produced that has characterized the annual record of the natural-gas industry in Illinois since 1909 was not reversed in 1915. The volume produced in 1915 was, in fact, less than that produced in any other year since 1907, when the production exceeded 1,000,000,000 cubic feet for the first time. Compared with the output in Illinois in 1914, that produced in 1915, which is estimated at 2,690,593,000 cubic feet, was less by 857,248,000 cubic feet, or 24 per cent. Compared with the output in 1913, that in 1915 declined 44 per cent.

The decreased production in 1915 is accounted for partly by the fact that the volume obtained from gas wells in 1915 averaged less per well than that obtained in previous years but principally by the fact that fewer gas wells were completed in 1915 than in any other year since 1906. In 1915 only 28 gas wells were completed, whereas 66 exhausted wells were abandoned. The decrease in field activity is a direct reflection of conditions in the petroleum industry, which were not such as to encourage the drilling of wells for oil until the closing months of the year. As a consequence drilling activity in the oil fields of Illinois, which comprise its sources of natural gas, was less than in any other year since 1905, when the petroleum industry of the State began to assume commercial importance. The drilling that was done was restricted principally to areas of known worth, in which the gas supply had already been depleted.

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The year 1915 was not, however, wholly devoid of significant developments of interest to the local gas industry. The most important of these was in Macoupin County, where test wells drilled during the year demonstrated the presence of a large volume of gas in the Staunton dome. The circumstances leading to the discovery of this new field and the results of the work accomplished there in 1915 are described by Kay[1] as follows:

In 1914 the Illinois Geological Survey described a dome northwest of Staunton, Macoupin County.[2] The existence of the dome was determined by the position of coal No. 6 in coal-test holes drilled by the Chicago & North Western Railway Co. It was later described in greater detail by Wallace Lee, of the United States Geological Survey, in cooperation with the Illinois Survey.[3] Early in 1915 Miller Bros., of Staunton, drilled a well near the highest part of the dome in the southeast corner of the SW. ¼ SW. ¼ sec. 14, T. 7 N., R. 7 W. (Dorchester), and brought in a large production of gas from a sand at 441 feet. Prospecting was stimulated, and before the end of the year a number of wells were drilled in the area. In the N. ½ sec. 23 and the S. ½ sec. 14 seven gas wells were completed, the largest of which (Daniel Groves No. 1) is reported to have a capacity of 20,000,000 cubic feet per day.

One mile northwest of the principal gas area the Ohio Oil Co. drilled G. W. Groves No. 1 in the northeast corner of the SE. ¼ NW. ¼ sec. 15, T. 7 N., R. 7 W., and at 461 feet reached a sand that produced about 2,000,000 cubic feet of gas per day. At 480 feet a show of black oil was found, and at 565 a good show of green oil was developed. Salt water came in at the same time. About 1 mile southeast of the main gas wells the Miller Bros. completed a 5-barrel oil well at the center of sec. 24, T. 7 N., R. 7 W. The sand lies at 442 feet. In the SE. ¼ SW. ¼ sec. 24, Fleeger & Lamberton discovered gas at 427 feet with a reported flow of about 700,000 cubic feet per day.

The large gas wells are located on the top of the dome, where the beds lie from 40 to 60 feet higher than in the surrounding area. * * *

The producing sands lie in the basal part of the "Coal Measures," the upper one occupying about the position of coal No. 2. No single sandstone can be traced throughout the area; in other words, the sands were probably deposited in channels whose streams eroded away the beds such as the coals normally in the bottom part of the "Coal Measures." Two such lenses are represented in the larger gas wells, the top of the first being from 195 to 215 feet below the top of coal No. 6, whereas in H. Woolridge No. 1, SW. ¼ SE. ¼ sec. 14, T. 7 N., R. 7 W., no sand was found at the upper horizon, but 255 feet below coal No. 6 a good flow of gas was tapped in a lower lens.

This lower sand corresponds in position with the sand from which oil is obtained in the Miller oil well at the center of sec. 24, T. 7 N., R. 7 W. Whether or not the sand is continuous between the two wells must be decided by the drill. It is probable that the sand 233 feet below the coal in the gas well, NW. ¼ NE. ¼ sec. 23, T. 7 N., R. 7 W., represents a lens intermediate between the two mentioned above.

During the second half of July and the first half of August activity was retarded by litigation between the gas and the coal companies, whose interests conflicted in this locality. A temporary injunction, restraining the gas companies from drilling through coal beds known to underlie certain parts of the prospective oil and gas area, was dissolved by a decree that permitted the gas companies to proceed with development, subject, however, to a limitation of three wells on each 40 acres and to a decision by officials of the coal companies as to the locations of the wells.

[1] Kay, F. H., Petroleum in Illinois in 1914 and 1915: Illinois Geol. Survey Bull. 33, pp. 15–16, 1916.

[2] Blatchley, R. S., Oil and gas in Bond, Macoupin, and Montgomery counties: Illinois State Geol. Survey Bull. 28, 1914. Also Kay, F. H., Coal resources of District VII: Illinois Coal Mining Investigations Bull. 11, 1915.

[3] Lee, Wallace, Oil and gas in Gillespie and Mount Olive quadrangles: Illinois Geol. Survey Bull. 31, p. 101, 1915.

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To the end of 1915 no market had been found for the large volume of gas found in this field.

The greater part of the gas produced commercially in Illinois came in 1915, as in previous years, from the oil fields in Cumberland, Clark, Crawford, and Lawrence counties, where sufficient gas is produced to operate the oil wells and to supply domestic and industrial consumers in a number of adjacent cities and towns, including Vincennes, Ind.

Aside from this commercial source, natural-gas flows of sufficient volume to supply from one to three households each are obtained from individual wells in parts of Bond, Bureau, Champaign, Dewitt, Edgar, Lee, Logan, Montgomery, Morgan, and Pike counties. In McLean County natural gas for domestic consumption in the village of Heyworth is obtained from one well, which has furnished a satisfactory supply of gas for a number of years.

CONSUMPTION.

Including the quantity of natural gas piped from Illinois to supply consumers in Vincennes, Ind., the volume of gas consumed in Illinois in 1915 was equivalent to the quantity produced in the State.

The average price paid for this gas at the point of consumption was 13.02 cents a thousand cubic feet, the total market value of the gas consumed being $350,371. Compared with corresponding data for 1915, these statistics show an increase of 0.70 cent in average unit price, but a decrease of $86,904, or 20 per cent, in total market value.

Of the quantity of natural gas consumed in Illinois in 1915 about 704,696,000 cubic feet, or 26 per cent, was supplied to 8,610 domestic consumers at an average price of 27.25 cents a thousand cubic feet, and the remainder was supplied to 134 industrial consumers at an average price of 7.97 cents a thousand.

A comparison of these data with corresponding statistics for 1914 shows, with regard to domestic consumption, decreases of 9 per cent in the volume of gas consumed, of 0.08 cent in average unit price, and of 4 per cent in the number of consumers; with regard to industrial consumption, decreases of 28 per cent in volume, of 0.19 cent in average unit price, and 12 per cent in the number of consumers.

The principal distributors of natural gas produced in Illinois are the Lawrence Gas Co., supplying Bridgeport (in part) and Lawrenceville; the Olney Gas Co., supplying Olney; the Wabash Gas Co., supplying Annapolis, Eaton, Hutsonville, Marshall, Martinsville, and Robinson; the Vandalia Gas Co., supplying Casey; the Oblong Gas Co., supplying Duncanville, New Hebron, Oblong, Palestine, and Stoy; the Bond County Gas Co., supplying Greenville; the Heyworth Gas Co., supplying Heyworth; and the Vincennes Gas Co., supplying Flat Rock and Bridgeport (in part) in Illinois and Vincennes in Indiana.

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Record of natural-gas industry in Illinois, 1906–1915.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	66	$87,211	1,429	2	$87,211			220
1907	128	143,577	2,126	61	143,577	94	41	253
1908	185	446,077	[a]7,377	[a]204	[a]446,077	121	42	409
1909	194	644,401	[a]8,456	[a]518	[a]644,401	56	11	423
1910	207	613,642	[a]10,109	[a]261	[a]613,642	64	31	458
1911	225	687,726	[a]10,078	[a]293	[a]687,726	69	78	488
1912	223	616,467	[a]10,891	[a]212	[a]616,467	56	147	453
1913	231	574,015	[a]10,423	[a]279	[a]574,015	60	119	455
1914	235	437,275	[a]8,952	[a]153	[a]437,275	38	114	416
1915	226	350,371	[a]8,610	[a]134	[a]350,371	28	67	378

[a] Includes number of consumers and value of gas consumed in Vincennes, Ind.

Depth and rock pressure of wells in Illinois, 1911–1915.

County.	Depth (feet).	Pressure (pounds).				
		1911	1912	1913	1914	1915
Bond	925–1,100	100–350	40–410	35–355	40–350	100–350
Lawrence	700–1,900					
Bureau	98– 257	0– 42	0– 80	0– 42	0– 35	0– 25
Champaign	80– 140	15– 30	0– 20	0– 30	0– 30	0– 45
Clark	250– 640	10– 60	15–105	0– 30		20– 35
Crawford	400–1,550	10–150	20–200	20–350	25–450	25–200
Cumberland	500–1,000				65	
Dewitt	85– 127	20– 50	0– 50	0– 25	0– 20	0– 50
Edgar	230– 600	50– 90	75–130	50–135	80–135	40–120
Lee	126– 280	19– 28	12– 28	12– 20	15– 28	2– 28
Logan	84– 90					
McHenry	160– 372	10– 22				
McLean						
Macoupin						
Montgomery	55– 67			1– 2		
Morgan	226– 400	0–100	0–100	0– 96	0– 20	0– 35
Pike	89– 350	1– 20	0– 10	0– 9	0– 53	0– 10

MISSOURI.

The quantity of natural gas profitably produced in Missouri in 1915 is estimated at 27,645,000 cubic feet and its value at $7,731, representing an average price of 28 cents a thousand cubic feet—a gain of 53 per cent in quantity and of 45 per cent in total value, but a loss of 1.4 cents in average unit price, compared with 1914.

Aside from the natural gas produced within the boundaries of the State a large volume of gas accounted for in the statistics for Kansas and Oklahoma, where it was produced, was piped into Missouri and consumed in the towns and smelters in the lead and zinc district adjacent to Joplin and for domestic purposes in Kansas City.

The increase in production of gas credited to Missouri in 1915 was due principally to developments in Platte County, where, in March, Jones, Fickle & Baird began distributing natural gas from four wells less than 600 feet deep to consumers in the town of Parkville and the adjacent rural district.

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Three wells in Jackson County supplied 33 domestic and 4 industrial consumers of natural gas in Martin City during 1915, and 4 other wells in this county supplied 29 additional consumers living in the vicinity of the wells. Steps were taken in 1915 toward a more thorough testing of the territory in northwestern Jackson County in the hope of developing a supply of natural gas sufficient to warrant the laying of mains to Kansas City.

Near Holden, Johnson County, one gas well, the product of which remained unutilized to the end of the year, was completed in 1915 by the Missouri & Texas Oil & Gas Co.

In Bates and Cass counties natural gas, under a pressure of 10 to 120 pounds per square inch, is obtained in wells ranging in depth from 120 to 600 feet in sufficient quantities to supply from one to three households each.

The number of natural-gas producers in Missouri decreased from 49 in 1914 to 44 in 1915, but the number of consumers of Missouri gas increased from 126 domestic and 7 industrial in 1914 to 174 domestic and 9 industrial in 1915.

KANSAS.

PRODUCTION.

As a consequence of the success that attended field activity in the search for petroleum and natural gas in Kansas during 1915, the output of gas showed an increase that was gratifying to the consumers who have witnessed with considerable apprehension the steady decline in production of gas in this State during recent years. It is estimated that 27,045,908,000 cubic feet of gas was produced and utilized in Kansas in 1915, a quantity greater by 4,418,401,000 cubic feet, or 19 per cent, than the volume produced in 1914, but still 30 per cent below the record production in 1911.

Credit for the increase in production of gas belongs principally to the Augusta field, in Butler County, where a large number of gas wells of large capacity have been completed during the last two years. This field was discovered in 1913, and until 1915 was developed essentially for the gas supply found in a sand reached at a depth of about 1,500 feet. The gas field was extended gradually to include an area lying directly south of the city of Augusta, approximately 6 miles long from north to south and 1 to 3 miles wide. Gas wells in this field range in open-flow capacity from 2,000,000 to 40,000,000 cubic feet of gas a day. When the field was first opened the average rock pressure was 650 pounds to the square inch, but at the end of 1915 it had declined to about 400 pounds. Late in 1915 interest in this field became centered in the development of oil found in considerable quantities in sands reached at an average depth of 2,500 feet. A few years ago this circumstance would have meant the abrupt termination of the value of the field as a source of gas, but by the employment of modern methods of conservation the gas sand is effectually sealed with mud-laden fluid before the well is deepened to the oil sand. The gas supply is thus conserved and may be drawn upon when needed, either through the original well or through an adjacent well drilled to the productive sand. The employment of this process in the development of the oil resources of the Augusta field has resulted in only negligible losses of gas, and its employment in other fields in Kansas, as they are developed, will

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undoubtedly serve to lengthen greatly the life of the gas supply in this State.

The search for natural gas in Montgomery County, though especially active in 1915, was rewarded with wells of only average capacity. Gas wells in this county range from 160 to 1,600 feet in depth and from 500,000 to 2,000,000 cubic feet in initial daily yield.

In Labette County productive territory of promise was added to the gas field northeast of Coffeyville as a result of operations by the Ludowici Oil & Gas Co. on the Bowman and Straub farms.

In Chautauqua County the routine development of small capacity gas wells was enlivened in April by the completion on the Muder lease, in sec. 35, T. 33 S., R. 10 E., by Benson & Boviard, of a well that was credited with an initial capacity of 6,000,000 cubic feet of gas, and in December by the completion on the Jones lease, in sec. 10, T. 35 S., R. 12 E., by the Moore One Oil Co., of a well that was reported to have gaged 5,250,000 cubic feet of gas the first 24 hours after completion.

The natural-gas output of Woodson County was greatly increased in 1915 as a result of the discovery in July of a prolific gas pool in secs. 8 and 17, T. 26 S., R. 17 E., in the southeastern part of the county. Eleven wells completed in this pool in July were credited with a combined initial capacity of 41,500,000 cubic feet of gas, an average of 3,770,000 cubic feet for each well.

In Neosho County a number of gas wells of fair capacity were drilled in the vicinity of Chanute.

At the end of 1915 considerable interest was centered in a wildcat well in Greenwood County, 25 miles northeast of the Augusta field, that was completed in December by the Wichita Natural Gas Co. as a gas well having an initial capacity reported at 2,000,000 cubic feet, open flow. The well was located near Beaumont Junction, in sec. 34, T. 27 S., R. 8 E., and is said to have derived its production from a sand reached at about 1,200 feet. Additional wells were started in the locality, but the value of the field as a source of gas remained undemonstrated at the end of 1915.

The development in October and November of a number of good gas wells in the vicinity of Peoria and Rantoul, in eastern Franklin County, resulted in steps being taken toward the construction of a 6-inch pipe line from this area of production to the city of Ottawa. It was estimated in November that a supply of 25,000,000 cubic feet of gas a day could be readily obtained in this county to supplement the supply from other sources that was being distributed in Ottawa.

The number of producers of natural gas in Kansas increased in 1915 from 305 at the beginning of the year to 371 at the end, a gain of 22 per cent.

CONSUMPTION.

Including a small quantity of natural gas piped from Kansas and consumed in southwestern Missouri, the quantity of gas consumed in Kansas in 1915 was approximately 48,871,295,000 cubic feet, an increase of 8 per cent over the volume consumed in 1914. The average price paid for this gas was 16.73 cents a thousand cubic feet, and the total market value of the gas consumed was $8,174,289. Compared with the corresponding statistics for 1914 these data show increases of 1.8 cents in the average unit price and of $1,190,487, or 17 per cent, in the total market value of the gas consumed.

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Of the total quantity of gas consumed, 20,629,792,000 cubic feet, or 42 per cent, valued at $5,329,260, was distributed to 201,133 domestic consumers, at an average price of 25.8 cents a thousand cubic feet, and the remaining 58 per cent, valued at $2,845,029, was distributed to 1,446 industrial consumers at an average price of 10.1 cents a thousand. A comparison of these data with the corresponding statistics for 1914 shows in domestic consumption increases of 7 per cent in quantity, of 7 per cent in the number of consumers, of 0.34 cent in average unit price, and of 8.8 per cent in total market value; and in industrial consumption increases in 1915 of 8 per cent in quantity, of 36 per cent in the number of consumers, of 1.37 cents in average unit price, and of 16 per cent in total market value.

A further classification of the distribution of natural gas to industrial plants in Kansas in 1915 shows that approximately 8,534,494,000 cubic feet of gas, valued at $847,826, was supplied to zinc smelters, at an average price of 9.9 cents a thousand cubic feet; 1,553,625,000 cubic feet, valued at $122,828, to cement plants, at an average price of 7.9 cents a thousand; and 3,960,621,000 cubic feet, valued at $342,765, to brick, clay, and glass plants, at an average price of 8.65 cents a thousand.

Aside from the quantity of natural gas produced wholly within the borders of the State in 1915, there was consumed in Kansas and Missouri about 21,825,387,000 cubic feet of gas, valued at $4,137,278, which was piped from Oklahoma.

The principal wholesale distributors of natural gas in Kansas and southwestern Missouri are the Kansas Natural Gas Co., the Quapaw Gas Co., the Wichita Natural Gas Co., and the Wichita Pipe Line Co.

During 1915 gas service was extended to consumers in Atlanta, Belle Plaine, Bentley, Buffville, Burden, Burrton, Cambridge, Derby, Douglass, Grenola, Hackney, Halstead, Haven, Hunnewell, Mount Hope, Mulvane, New Salem, Oxford, Thayer, Udall, and Valley Center.

Record of natural-gas industry in Kansas, 1898–1915.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec 31.
			Domestic.	Industrial.		Gas.	Dry.	
1898	29	$174,640	[a] 6,186	44	$174,640	34	18	121
1899	31	332,592	[a] 10,071	71	332,592	44	22	160
1900	32	356,900	[a] 9,703	65	356,900	54	15	209
1901	48	659,173	[a] 10,227	72	659,173	71	35	276
1902	80	824,431	13,488	91	824,431	144	63	404
1903	120	1,123,849	15,918	143	1,123,849	295	66	666
1904	190	1,517,643	27,204	298	1,517,643	378	135	1,029
1905	171	2,261,836	46,852	601	2,265,945	340	157	1,142
1906	130	4,010,986	79,270	990	[b] 4,023,566	331	99	1,495
1907	196	6,198,583	149,327	1,605	[b] 6,208,862	361	163	1,760
1908	212	7,691,587	168,855	1,162	[b] 7,691,587	403	208	1,917
1909	199	8,293,846	182,657	1,160	[b] 8,356,076	452	214	2,138
1910	204	7,755,367	186,333	1,412	[c] 9,335,027	392	195	2,149
1911	232	4,854,534	199,523	907	[c] 9,493,701	301	152	2,033
1912	253	4,264,706	195,446	1,104	[c] 8,521,858	435	200	2,106
1913	305	3,288,394	195,131	950	[c] 6,983,802	506	253	2,297
1914	353	3,340,025	187,714	1,079	[b] 7,163,746	445	219	2,261
1915	371	4,037,011	201,133	1,446	[b] 8,174,289	554	194	2,443

[a] Number of fires supplied.
[b] Includes gas taken from Kansas and consumed in Missouri.
[c] Includes gas taken from Kansas to Missouri; also gas piped from Oklahoma to Kansas and Missouri.

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Depth and rock pressure of wells in Kansas, 1911–1915.

County.	Depth (feet).	Pressure (pounds).				
		1911	1912	1913	1914	1915
Allen	600–1,500	5–351	10–300	5–260	6–240	5–300
Anderson	230–1,070	60–225	30–240	65–250	65–225	60–225
Bourbon	150–800	40	40	75	75	80
Chase	64–1,100	1–400	7–80	3–95	10–a160	6–160
Crawford	100–640	20–40	15–50	40–50	30–90	40–176
Cowley	575–1,500					
Chautauqua	300–1,700	25–250	50–300	35–410	40–210	25–425
Douglas	350–450	30–120	10–280	20–60	10–a130	20–610
Johnson	130–950					
Ellsworth	950–1,250	.....	125–270	240–270	160–250	195–275
Elk	500–1,400	100–235	100	90–100	75	40
Butler	1,330–1,650	65–450	60–a525	550–a560	a400–a600	300–500
Woodson	650–1,150			.....	90–250	200
Greenwood	350–400	.....	.....	.....	.....	.....
Labette	320–1,000	25–235	23–185	20–240	50–200	42–195
Linn	85–750	22–110	6–70	20–100	20–100	10–100
Franklin	300–720	50–230	3–200	1–500	50–240	112
Miami	200–750				40–120	45–100
Montgomery	160–1,600	5–350	2–a515	5–700	15–400	15–175
Morris	600	.....	.....	.....	.....	250
Neosho	281–1,200	20–287	28–250	15–325	25–a360	0–200
Wilson	250–1,350	20–380	15–380	15–285	12–a350	30–475
Wyandotte	271–800	40–250	40–125	30–125	85	15–75

a New wells.

OKLAHOMA.

PRODUCTION.

The steady growth of the natural-gas industry in Oklahoma during the last decade was fully maintained in 1915. Exclusive of the quantity of gas produced in Oklahoma and consumed in Arkansas, which is accounted for in the statistics relating to the latter State, Oklahoma is credited with the production of 87,516,753,000 cubic feet of gas in 1915. This volume is greater by 9,347,339,000 cubic feet, or 12 per cent, than the production in 1914, and greater by 19 per cent than that in 1913.

As the supply of natural gas in Oklahoma is far in excess of the demands made on it, the increase in production, as the term is used in this report, reflects only the extensions made during the year in facilities for marketing gas from Oklahoma sources.

The market value of the gas produced in Oklahoma in 1915 was $9,195,804, a gain of $1,145,765, or 14 per cent, over the market value of the output in 1914.

The distribution of natural gas in Oklahoma is wide, and the local industry may be said to be only in its infancy, despite the fact that the volume of gas produced annually from this source during the last five years has been great enough to give Oklahoma third rank among the gas-producing States during that period. The production of natural-gas in this State is closely related to the production of petroleum, and with but few exceptions the most productive pools of petroleum have been the most important sources of natural gas. Though the close association of oil and gas in the same reservoirs in Oklahoma has resulted in the waste of billions of cubic feet of gas in the quest for oil, it is to this joint occurrence that Oklahoma owes its present commanding position in the casing-head

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gasoline industry and its enormous potentialities as a source of gasoline of this type.

Five new plants for the extraction of gasoline from natural gas were installed in Oklahoma in 1915, increasing the total number to 63 and increasing the daily capacity from 74,793 gallons at the beginning of the year to 111,463 gallons at its end. Additional data concerning this industry in Oklahoma may be found on pages 997 and 998 of this report.

So abundant is the supply of natural gas obtained incidentally in the search for petroleum in Oklahoma that few wells are drilled exclusively for gas in this State in the course of a year.

The most productive source of high-pressure gas in Oklahoma is the Cushing field, in western Creek County, where wells completed at depths of 1,600 to 2,600 feet yield initial flows of gas ranging from 10,000,000 to 25,000,000 cubic feet a day under pressures of 300 to 500 pounds to the square inch. In the majority of the wells drilled in this field the gas is cased off and the wells are deepened to the zone of oil production. The discovery and partial development during 1915 of the Shamrock pool, a southward extension of the Cushing district, added a considerable acreage to the productive gas territory in this State. In eastern Creek County gas wells with an initial daily capacity of 12,000,000 cubic feet are occasionally obtained in the Glenn pool, though wells of one-third this capacity are nearer the average in this district, which has been under development for the last 10 years.

In the Cherokee district, which has been under development for about 12 years, a considerable aggregate volume of low-pressure gas is still obtained, and the quantity available is used to supply local fuel needs and in the manufacture of gasoline, for which it is well adapted. The principal sources of supply in this district are the Bird Creek and Owasso pools, in Tulsa County, and the Inola pool, in Rogers County. During 1915 an area of gas production of moderate promise was proved in the vicinity of Vera, in the southeast corner of Washington County, and a number of excellent wells were completed in the Catoosa gas field, in the southwestern part of Rogers County. In May, 1915, the Kansas Natural Gas Co. extended a pipe line to the Catoosa field and began taking gas from this source to supply consumers in Kansas.

In the southern part of Tulsa County a number of gas wells were completed in the Lost City field, one of which, completed in May by Charles Page in sec. 18, T. 19 N., R. 12 E., is reported to have gaged 21,000,000 cubic feet of gas the first day after completion and to have registered a pressure of 425 pounds to the square inch. Gas from this field is supplied to consumers at Sand Springs, across Arkansas River from Lost City.

The completion, in October, as a gas well credited with an initial output of 20,000,000 cubic feet, of a wildcat test drilled in sec. 13, T. 19 N., R. 5 E., aroused considerable speculation as to the presence of an important gas field near Yale, in eastern Payne County.

Developments during 1915 in the Blackwell district, in northern Kay County, amply demonstrated the presence of an enormous volume of gas in this district in an area to the north of the shallow sand pool which has supplied gas for local consumption for a number

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of years. Well No. 1 on the Effie Myers lease, in sec. 5, T. 28 N., R. 1 E., completed in November by the Kay & Kiowa Gas Co., is reported to have gaged 20,000,000 cubic feet of gas the first 24 hours after completion from a sand entered at a depth of about 1,400 feet. In higher sands an aggregate of 25,000,000 cubic feet more was developed, but these sands were mudded off in the hope of reaching oil at a lower depth. North of this well, in sec. 32, T. 29 N., R. 1 E., an oil well completed in July by the Duluth-Oklahoma Oil Co. is reported to have yielded 12,000,000 cubic feet of gas a day under a rock pressure of 1,500 pounds to the square inch from a sand entered at a depth of about 3,400 feet. It is estimated that from the various gas sands penetrated and mudded off in the course of drilling this well a production of 60,000,000 cubic feet of gas a day is possible. Persistent effort is being made to conserve the tremendous volume of gas that has been proved to be present in this district until facilities can be provided for conveying it to markets. At the end of 1915 several projects were under way to pipe the gas from this area to various parts of southern Kansas.

Aside from the incidental development of large volumes of gas in wells drilled for oil in the productive fields of Wagoner, Muskogee, Okmulgee, and McIntosh counties, interest was aroused at different times in 1915 by discoveries of new areas of production of gas in different parts of the district included in these four counties.

In Wagoner County a new field of considerable potential importance was discovered in November on the south side of Arkansas River near the town of Stone Bluff, when a wildcat well drilled by Ross & Greis in sec. 5, T. 16 N., R. 15 E. was completed as a gasser that gaged 25,000,000 cubic feet the first 24 hours after completion. In the same month the completion by Humphries & Whiteside of a gas well near the village of Taft, in sec. 19, T. 15 N., R. 17 E., that was estimated to have an initial capacity of 6,000,000 cubic feet resulted in additional tests, which, however, remained uncompleted at the end of 1915.

In Okmulgee County new gas territory was opened in May near Natura by the completion as a gas well having an initial capacity estimated at 18,000,000 cubic feet of a wildcat test drilled by Young and others in sec. 23, T. 15 N., R. 13 E.

In McIntosh County interest was centered in the area adjacent to Checotah, where a number of gas wells of large capacity were brought in during the year.

In southern Oklahoma a gas field of increasing importance is being developed in Pontotoc County, in the vicinity of Ada, which provides a convenient market for the gas produced.

In the Healdton field, Carter County, natural gas is present in quantities far in excess of the requirements of tributary markets, and the same statement may appropriately be made concerning the Loco and Duncan fields in Stephens County. At the end of 1915 interest in the Healdton district was focused on an important wildcat well being drilled by the Gypsy Oil Co. in sec. 28, T. 2 S., R. 3 W. Before the end of December this well was reported to have penetrated two productive gas sands, one at a reported depth of 1,845 feet and the other at about 2,000 feet, the combined capacity of which it was estimated would amount to 20,000,000 cubic feet of gas a day.

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The number of producers of natural gas in Oklahoma decreased from 437 at the end of 1914 to 434 at the end of 1915, but the total area held for gas development in the State increased from 1,195,777 to 1,292,692 acres.

CONSUMPTION.

Including the quantity of gas piped from Oklahoma and consumed in southwestern Missouri, the quantity of natural gas consumed in Oklahoma in 1915 is estimated at 65,691,366,000 cubic feet, valued at $5,058,526, at an average price of 7.70 cents a thousand cubic feet. Compared with the corresponding statistics for 1914 these data show increases of 10,147,261,000 cubic feet, or 18 per cent, in quantity; of $832,208, or 20 per cent, in total market value; and of 0.1 cent in average unit price.

Of the natural gas consumed in 1915 about 10,047,410,000 cubic feet, or 15 per cent, valued at $1,805,826, or 36 per cent of the total value of gas consumed, was supplied to 67,874 domestic consumers at an average price of 17.97 cents a thousand cubic feet. The remainder was distributed to 1,551 industrial consumers at an average price of 5.85 cents a thousand.

Compared with the corresponding items for 1914, the domestic consumption of natural gas in Oklahoma increased 30 per cent in quantity and 25 per cent in total market value, whereas the number of consumers increased only 9 per cent and the average unit price decreased 9 per cent; likewise industrial consumption increased 16 per cent in volume of gas, 18 per cent in total market value, and 2 per cent in average price, but decreased 20 per cent in the number of consumers.

A further classification of the distribution of natural gas to industrial plants in Oklahoma in 1915 shows that approximately 16,247,527,000 cubic feet, or 29 per cent, valued at $801,825, was distributed to smelters at an average price of 4.9 cents a thousand cubic feet, and 3,852,714,000 cubic feet to cement, brick, glass, iron, and carbon-black plants at an average price of 3.4 cents a thousand. Smelters in Oklahoma supplied with natural gas in 1915 are located as follows: Bartlesville, three plants, owned by the Bartlesville Zinc Co., the Lanyon-Starr Smelting Co., and the National Zinc Co.; Collinsville, two plants, owned by the Bartlesville Zinc Co. and the Tulsa Fuel & Manufacturing Co.; Sand Springs, plant of the United States Zinc Co.; Henryetta, plant of the Henryetta Spelter Co.; Kusa, plant of the Kusa Spelter Co.

The remainder of the gas supplied to industrial consumers in Oklahoma in 1915 was utilized in the manufacture of casing-head gasoline and in the development of power for field, pipe-line, and cotton-gin operations.

Of the total volume of natural gas produced in Oklahoma in 1915 about 21,825,387,000 cubic feet, valued at $4,137,278 was supplied to consumers in Kansas and Missouri and is accounted for in the statistics of gas consumption in Kansas.

In Oklahoma natural-gas service was extended in 1915 to Ada, Bartlett, Cathay, Commerce, Locust Grove, Oilton, Spiro, Stidham, Whiteagle, and Wirt.

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Record of natural-gas industry in Oklahoma, 1906–1915.

Year.	Gas produced.		Gas consumed.			Wells.		
	Number of producers.	Value.	Number of consumers.		Value.	Drilled.		Productive Dec. 31.
			Domestic.	Industrial.		Gas.	Dry.	
1906	50	$259,362	8,391	202	$247,263	81	33	239
1907	107	417,221	11,038	277	406,942	99	41	344
1908	115	860,159	17,567	356	860,159	73	40	374
1909	131	1,806,193	32,907	1,527	1,743,963	97	35	454
1910	168	3,490,704	38,617	1,557	1,911,044	93	58	509
1911	204	6,731,770	44,854	1,507	2,092,603	303	143	732
1912	242	7,406,528	47,017	1,651	3,149,376	329	197	936
1913	347	7,436,389	49,308	1,793	3,740,981	423	298	1,052
1914	437	8,050,039	62,390	1,951	[a] 4,226,318	388	182	1,205
1915	434	9,195,804	67,874	1,551	[a] 5,058,526	209	118	1,229

[a] Includes some gas piped from Oklahoma to Missouri.

Depth and rock pressure of wells in Oklahoma, 1911–1915.

County.	Depth (feet).	Pressure (pounds).				
		1911	1912	1913	1914	1915
Cherokee	600– 650					
Hughes	1,000–2,000		200	10– 350		500
Carter	590–1,840	48–150			30– 325	50– 370
Comanche	380–1,000				286– 400	78
Craig	500– 520					
Latimer	1,575–1,600	40–470			151– 400	
Sequoyah	1,200					
Creek	400–2,900	20–700	40–850	20– 900	40– 800	40– 400
Kay	436–3,280	40–390	165–365	40– 650	35– 450	50–[a] 1,500
Kiowa	350– 825	10– 50			30	
Le Flore	1,300–2,200	300–355	350–355	300– 375	385	140– 350
McIntosh	962–2,740		150–600	150– 400	[a] 900	110–[a] 1,200
Marshall	420– 576				150	135– 150
Mayes	106– 640					40– 80
Muskogee	800–1,910	18–225	15–350	10– 350	20– 275	20– 20
Nowata	450–1,700	60–450	25–150	25– 300	39– 150	85– 310
Okfuskee	1,450–2,220				[a] 700	[a] 790
Okmulgee	600–2,600	100–700	300	80–[a] 800	80–[a] 840	300–[a] 1,000
Osage	900–2,500	150–650	200–780	100– 700	150–[a] 800	150– 680
Pawnee	1,000–3,150	200–450	40–800			[a] 860
Coal	400–2,200				110– 425	
Pittsburg						
Pontotoc	1,090–1,251					
Greer	390					
Payne	2,940–3,150				[a] 800	[a] 900
Rogers	380–1,800	90–480	40–525	25– 500	145– 400	50– 350
Stephens	600–1,200		300–325	250– 330	240– 345	263
Tulsa	580–2,200	80–400	50–625	100– 650	70– 525	40– 600
Wagoner	550–1,700	100–300			165– 405	230– 325
Washington	315–2,260	15–620	10–250	19– 350	25–[a] 635	30– 300

[a] New wells.

ARKANSAS.

Considerable impetus was given to the natural-gas industry in Arkansas by the discovery of a new gas field of considerable promise in Crawford County, 7 miles east of Van Buren. The discovery well was drilled in sec. 31, T. 9 N., R. 30 W., by the Clear Creek Oil & Gas Co., of Fort Smith. It was completed November 13, 1915, at an approximate depth of 2,300 feet, and was credited with an initial

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capacity of 15,000,000 to 20,000,000 cubic feet of gas a day and a closed pressure of 265 pounds to the square inch. Additional wells completed near this producer early in 1916 confirmed the importance of the discovery and assured the development of a gas field of considerable value in its vicinity. This new area of gas production has been named the Kibler field.

About 8 miles southwest of the Kibler field is the Massard Prairie field, in Sebastian County, which is the principal source of the gas supplied to the cities of Fort Smith and Van Buren and adjacent rural districts. It lies about 6 miles southeast of Fort Smith and occupies the crest of an elongated dome known as the Massard Prairie anticline. At the close of 1915 there were some 87 active gas wells in this field, ranging in depth from 1,250 to 2,350 feet, in which the rock pressure averaged about 25 pounds to the square inch. In addition to the entire output of this field considerable gas is imported from Oklahoma to supply the domestic and industrial needs of natural-gas consumers in Fort Smith and Van Buren.

In southern Sebastian and northern Scott counties 10 wells on the Hartford anticline provide natural gas for 261 domestic and 50 industrial consumers in Mansfield and in Huntington and vicinity. The range in depth of wells in this field is from 800 to 2,300 feet, and the average rock pressure at the close of 1915 was 285 pounds, a decrease of about 10 pounds during the year.

Near Vick, in Bradley County, a 3,000-foot wildcat well drilled for the Vick Oil & Gas Co. furnished a small flow of gas that is utilized for domestic purposes in a hotel.

There were nine producers and 5,797 domestic and 59 industrial consumers of natural gas in Arkansas in 1915. The number of productive gas wells on December 31 was 101, three productive wells having been completed and one exhausted well abandoned during the year.

In addition to consuming the entire quantity of gas produced within the State, as well as some gas produced in Oklahoma, already referred to, considerable natural gas was piped from Louisiana for consumption in cities and towns in Arkansas adjacent to the southern boundary, statistics of which are included with those for Louisiana.

LOUISIANA.

PRODUCTION.

The quantity of natural gas produced in Louisiana in 1915 is estimated at 25,540,392,000 cubic feet, a decrease of about 4 per cent from the production in 1914. As the production of natural gas in Louisiana is largely incidental to the development of its oil fields, the slight decline in output may be ascribed to the transfer in 1915 of drilling activity from the older oil fields of Caddo Parish, which yield the greater part of the State's supply of gas, to the newer fields in Red River Parish, where the recovery of oil was the first consideration and where the only use for the gas obtained was for field operations.

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The value of the natural gas produced in Louisiana in 1915 was $2,163,934 at the point of consumption, an average of 8.5 cents per thousand cubic feet. The total value in 1915 is less by about 2 per cent than the value of the output in 1914, but the average unit price is 0.2 cent greater.

The most important field developments in the natural-gas industry in 1915 were in the vicinity of Shreveport, where a number of wells drilled for oil proved the presence of gas in large quantities adjacent to the city. The feature of this development was well No. 3 of the Gulf Refining Co., on the Youree tract, in sec. 17, T. 17 N., R. 13 W., on Harts Island, just south of Shreveport. This well was completed late in November at a depth of about 2,300 feet and was credited with an initial open-flow capacity of 22,000,000 cubic feet of gas a day under a reported pressure of 1,100 pounds to the cubic inch. Aside from its exceptional size this well is important because of its location in undeveloped territory, about 4 miles east of the gas wells near the Shreveport Fair Grounds and about 6 miles southeast of the gas development at Gas Center.

Considerable interest was aroused late in 1915 by the discovery of gas in sufficient quantities to provide fuel for additional drilling in a wildcat test drilled by the Black Lake Oil & Gas Co. on the east side of Black Lake, in sec. 28, T. 11 N., R. 6 W., in the eastern part of Natchitoches Parish.

In the Caddo field, which supplies more than half the gas produced in Louisiana, the average rock pressure of the gas obtained from the old wells was about 45 pounds to the square inch at the end of 1915, compared with about 55 pounds at the end of 1914. On the gas obtained from new wells the pressure ranges from 100 to 300 pounds to the square inch, depending on the depth of the well and its relation to other producing wells.

In the newer fields in De Soto Parish the rock pressure ranges from 100 pounds to the square inch on gas from the shallow sands to as high as 750 pounds to the square inch on gas from the deep sands, the average pressure in the shallow zones having declined nearly 200 pounds within the last year.

In the Crichton field, Red River Parish, discovered in 1915, where production is obtained from depths of 2,500 to 2,700 feet, the rock pressure averaged about 400 pounds to the square inch at the end of the year.

Producers of natural gas in Louisiana in 1915 increased in number from 54 to 57 and active gas wells from 238 on January 1 to 253 on December 31, a total of 35 productive gas wells having been completed and 20 exhausted wells abandoned during that period.

The total area reported held for gas development in Louisiana increased from 125,367 acres at the end of 1914 to 254,525 acres at the end of 1915.

CONSUMPTION.

Including the gas piped from Louisiana to adjacent parts of Arkansas and Texas the quantity of natural gas consumed in Louisiana in 1915 was equivalent to the quantity produced, as no gas from external sources is consumed in this State.

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The principal wholesale distributor of Louisiana gas in 1915 was the Reserve Natural Gas Co., of Shreveport, which late in 1914 completed a 16-inch pipe line from Naborton, in De Soto Parish, northward to Oil City, in Caddo Parish, a distance of about 50 miles. This company purchases large quantities of gas in the southern fields and transports it northward to supply the Arkansas Natural Gas Co., the Southwestern Gas & Electric Co., the Marshall Gas Co., all large distributing organizations formerly dependent on the Caddo district for their gas, and various operators in the northern fields. The Arkansas Natural Gas Co., which obtains its gas supply in part from this source and in part by direct purchase from operators in the Caddo district, distributes natural gas to the towns of Ida, Lewis, and Oil City, La., and to the Consumers Gas Co. and the Little Rock Gas & Fuel Co., which supply consumers in Hot Springs and Little Rock, Ark., respectively.

The Southwestern Gas & Electric Co. is the most important retailer of Louisiana gas. Through its Caddo, Shreveport, and Texarkana divisions it supplies consumers in Shreveport, Bossier City, Cedar Grove, Blanchard, Mystic, Rodessa, Mooringsport, Oil City, and Vivian, La., and Ravenna and Texarkana, Ark., besides furnishing the gas distributed to consumers in Atlanta and Queen City, Tex., by the Atlanta Gas Co., and in Texarkana, Tex., by the Texarkana Gas Co.

The Marshall Gas Co. distributes Louisiana gas to consumers in Marshall and Leigh, Tex.

Other distributors of Louisiana gas include the Shreveport Natural Gas Co., supplying consumers in Shreveport; the Mansfield Gas Co., supplying consumers in Naborton and Mansfield; and the Red River Gas Co., supplying consumers in Belcher and Dixie.

Besides the natural gas distributed by these companies large quantities are consumed in gas engines that supply power for drilling and pumping operations in the oil fields. Much of the gas used in this way is not metered but is supplied at a flat rate of $5 to $10 a day, and estimates of the quantity involved have been necessary.

Available data show that of the 25,540,392,000 cubic feet of Louisiana gas consumed in 1915, 15 per cent was distributed to domestic consumers at an average price of 26.9 cents a thousand cubic feet; 10 per cent was distributed to manufacturing plants at an average price of 7.5 cents a thousand cubic feet, and the remaining 75 per cent was consumed in the production of power, for which it was sold at an average price of 4.9 cents a thousand cubic feet.

Prices of Louisiana gas to domestic consumers averaged the same in 1915 as in 1914; to manufacturing plants the average price increased from 6.8 cents to 7.5 cents per thousand cubic feet; but for power plants a very slight decrease was recorded.

Domestic consumers of natural gas produced in Louisiana increased from 29,751 in 1914 to 30,144 in 1915 and manufacturers from 67 to 93, whereas other industrial consumers decreased from 521 to 504.

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Record of natural-gas industry in Louisiana, 1909–1915.

Year.	Number of producers.	Number of consumers.		Total value of gas produced.	Wells.		
		Domestic.	Industrial.		Drilled.		Productive Dec. 31.
					Gas.	Dry.	
1909	11	4,034	164	[a] $326,245	26	10	70
1910	21	8,547	320	[a] 509,408	23	4	91
1911	27	[b] 17,964	442	[a] 858,145	36	18	116
1912	41	[b] 24,087	474	[a] 1,747,379	50	20	155
1913	57	[b] 26,424	550	[a] 2,119,948	53	24	191
1914	54	[b] 29,751	618	[a] 2,227,999	52	26	238
1915	57	[b] 30,144	597	2,163,984	35	10	253

[a] Includes the production of Alabama.
[b] Includes consumers supplied with gas piped from Louisiana to Arkansas and Texas.

Depth and rock pressure of wells in Louisiana, 1912–1915.

Parish.	Depth (feet).	Pressure (pounds).			
		1912	1913	1914	1915
Caddo	750–2,900	80–910	60–850	20–325	40–300
De Soto	746–3,224	400–450	350–450	338–716	[a] 466
Lafourche	80– 100	25	20	5– 10	15
Ouachita	1,200–3,240	.....	.....	Small.	.....
Red River	2,515–2,668	.....	.....	.....	[a] 400
Terrebonne	93– 105	.....	.....	50	34

[a] New.

TEXAS.

PRODUCTION.

The quantity of natural gas profitably produced in Texas in 1915, estimated at 13,323,747,000 cubic feet, was less by 109,892,000 feet, or about 1 per cent, than the corresponding production in 1914. This slight decrease is attributed to the fact that the output of utilized gas from the newer fields in the State was insufficient to offset the normal decline in production in the Petrolia field, Clay County, from which the greater part of the gas utilized in Texas is obtained.

The average price received for the natural gas produced in Texas in 1915 was 19.5 cents per thousand cubic feet, and the total market value of the output was $2,593,873, a gain of 1.1 cents in unit price, and of $124,103, or 5 per cent, in total value, compared with 1914.

At the request of the municipal authorities of the cities of Dallas and Fort Worth, the United States Geological Survey in the fall of 1915 made an investigation of the natural-gas resources of certain areas in northern and central Texas to determine the sufficiency and prospective duration of the gas reserves under development within a reasonable distance of those cities. The results of this investigation [1] indicate that the supply of natural gas available to these con-

[1] Shaw, E. W., Gas in the area north and west of Fort Worth; Matson, G. C., Gas prospects south and southeast of Dallas; Wegemann, C. H., Notes on the gas fields of central and southern Oklahoma: U. S. Geol. Survey Bull. 629, 1916.

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suming centers is ample, with careful development, for three or four years without the development of new fields or the discovery of deeper-lying zones of production in the fields already developed.

The principal area of gas production in Texas is the Petrolia district, in Clay County, concerning which Shaw[1] says:

Original amount of gas.—The quantity of gas originally in the Petrolia field may be computed roughly from the total volume of pore space in the gas-bearing rock and the gas pressure at the time the first gas well was drilled. If the average original pressure was 725 pounds to the square inch, the gas would have occupied a little more than one-fiftieth of the space it would have occupied at 8-ounce pressure. If the area originally underlain by the gas were 15 square miles, the average thickness of pay sand 30 feet, the average pore space 20 per cent, and the pressure 725 pounds per square inch, the original quantity of gas would have been 120,432,000,000 cubic feet, which, if all recovered and used at an average rate of 10,000,000,000 cubic feet per year, would last 12 years. The production could not, of course, be kept up at this rate until the gas had been exhausted, so there would be a gradual decline in the production and the life of the pool would be somewhat longer.

Quantity of gas thus far produced.—The quantity of natural gas produced in Clay County from 1907, the year the first well was drilled, to 1915 is about 37,000,000,000 cubic feet. This figure is based on the statistics showing the quantity of gas marketed. An estimate based on the pressure gradient and the thickness, volume, and percentage of pore space of the sand gives, however, a considerably larger figure, and it seems that the field has been depleted by about 50,000,000,000 cubic feet, the difference being the wasted and other unmarketed gas.

According to these calculations, the gas supply of the Petrolia field is about 40 per cent exhausted, the quantity remaining being, roughly, 70,000,000,000 cubic feet.

The average closed pressure of the wells in this field was about 240 pounds to the square inch at the end of 1915, a decline of 90 pounds during the year, as against 180 pounds during 1914.

The composition and fuel value of natural gas from the Petrolia field are shown in the following table:[2]

Analyses of three samples of gas from Petrolia field.

[G. A. Burrell, analyst, Bureau of Mines, Nov. 19, 1915.]

[Nos. 6751 and 6752 are from Wichita Falls Gas Co.'s No. 1 Matlock well, which supplies the town of Petrolia; the third sample (X) is from Beatty No. 1 well, and the figures were furnished by the Lone Star Gas Co. G. A. Burrell, analyst, Bureau of Mines, Nov. 19, 1915.]

	6751	6752	X
CO_2	Trace.	0.2	0.2
O_2	.0	.0	.0
CH_4	48.5	48.4	52.7
C_2H_6	12.8	12.8	9.3
N_2	38.7	38.6	37.8
	100.0	100.0	100.0

6751 and 6752. Specific gravity (air=1), 0.78; heating value per cubic foot at 0° C. and 760 millimeters pressure, 755 British thermal units.

X. Specific gravity (air=1), 0.76; heating value, 734 British thermal units.

The most striking and important characteristic is the high nitrogen content of the gas. On account of the large percentage of this inert element the heating value is only 755 British thermal units, or about the same as that of artificial coal gas, whereas the Mexia and many other natural gases show over 1,000 British thermal units.

[1] Op. cit., pp. 36–37. [2] Op. cit., p. 41.

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At the end of 1915 gas was being utilized from 49 wells in this field.

Ranking second in the production of commercial gas is the Mexia-Groesbeck field, in the east-central part of Limestone County, a relatively new gas field, concerning which Matson[1] says:

> The Mexia-Groesbeck field, when examined in October, 1915, contained 2,331,057,000 cubic feet of gas, under a pressure of 200 pounds per square inch. This volume may be regarded as comparatively unimportant, but when it is considered that gas is consumed under a much lower pressure and has a much greater volume, it will be found that there is enough gas remaining in this field to be important. The gas now in the field, if placed in a container under a pressure of 15 pounds per square inch, would have a volume of 31,080,766,666 cubic feet. If the prospective consumption from this field by the cities now being supplied be estimated at 1,500,000,000 cubic feet a year, this amount of gas could be expected to last for more than 20 years, or if the computations made are regarded as too great by as much as 50 per cent it would still last more than 10 years, provided there was no loss from leakage. If the amount of gas allowed to escape from wells and pipe lines continues to be as great as in the past, the field should supply the present demands for 5 to 7 years, and the percentage of the actual amount of gas from the sand that can be used will ultimately depend on the skill of the engineer in drawing it from the ground and transporting it to the market.
>
> The present capacity of the wells, estimated at 10 per cent of the open-flow volume, would be about 22,000,000 cubic feet a day, but if the field is drawn upon at this rate without improving existing conditions of the wells many of them will continue to supply gas but a short time. If these wells should be improved and gas drawn from the wells at the rate of 22,000,000 cubic feet a day, the total volume in the field would last about 3¾ years; but again it is necessary to consider the ratio of consumption to waste, and the actual life of the field under such conditions will depend on this ratio.

The average pressure of the wells in this field was 200 pounds to the square inch at the end of 1915, as compared with 240 pounds at the end of 1914, 273 pounds at the end of 1913, and 275 pounds at the end of 1912, the year in which the field was discovered.

The composition and fuel value of four samples of gas from this field are as follows:[2]

Analyses of gas from the Mexia-Groesbeck district.

[G. A. Burrell, analyst.]

	1	2	3	4
CO_2	0.6	0.2	0.7	Trace.
O_2	.0	.0	.0	0.0
CH_4	98.4	98.3	98.1	98.5
N_2	1.0	1.5	1.2	1.5
	100.0	100.0	100.0	100.0
Specific gravity (air=1)	0.57	0.56	.057	0.56
Heating value at 0° C. and 760 millimeters pressure, in British thermal units	1,047	1,047	1,045	1,052

At the end of 1915 there were 46 productive gas wells in this district.

In the Moran oil and gas field, near the southeast corner of Shackelford County, there were no important developments with respect to natural gas in 1915. Four new gas wells were completed and, at the end of the year, gas was being produced commercially from 14 wells

[1] Op. cit., pp. 101–102.

[2] Op. cit., p. 102.

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ranging in depth from 1,950 to 2,950 feet and in rock pressure from 420 to 460 pounds per square inch. The rock pressure in the Moran gas field at the end of 1914 ranged between 600 and 700 pounds. The volume of gas utilized from this field in 1915 was about 60 per cent greater than in 1914, owing to the fact that gas from this source was supplied to the towns of Baird, Clyde, Putnam, Abilene, and Cisco during the entire year, whereas it was supplied to these towns during only a part of 1914.

Wells in the Reiser gas field, in Webb County, have supplied the needs of gas consumers in Laredo, the county seat, for a number of years. The decline in rock pressure and volume of gas available in this field, however, led the Border Gas Co. in 1915 to seek a new source of supply. This was found in Zapata County, 30 miles southeast of Laredo, where in 1914 a gas well, the open-flow capacity of which was estimated at 12,000,000 cubic feet, was completed on the ranch of J. D. Jennings. A 6-inch pipe line to intersect the 8-inch line from the Reiser field, at a point 15 miles east of Laredo, was under construction at the end of 1915.

Three wells, one of which was drilled in 1915, in the Bangs gas field, Bangs County, supply gas to more than 80 consumers in the town of Bangs.

Natural-gas flows accompanying water in a number of wells in the vicinity of Pleasanton, Atascosa County, supply the domestic needs of one to three families each.

In the Corpus Christi district, on the north side of Nueces Bay, San Patricio County, to which attention was attracted late in 1914 by the completion and loss of a monster gas well, the net result of operations in 1915 was a confirmation of the presence of enormous quantities of gas under great pressure in this area, without, however, the development of methods for controlling it. A number of tests were begun early in 1915 in the immediate vicinity of the "blow-out," described in the report of this series for 1914, and in the territory for several miles to the northwest and the southwest. In August, 1915, a gas flow estimated at 5,000,000 to 6,000,000 cubic feet a day was encountered at a reported depth of 2,020 feet in a well drilled by the Gulf Coast Oil & Gas Co. on the Kirk tract, 2 miles east of the discovery well. This well was successfully closed in at the time but broke loose in September and continued flowing gas and salt water to the end of the year.

On December 31 what is regarded by many as the largest gas well ever drilled in Texas blew itself in on the lease of the Gulf Production Co. in this district. This well was located 800 feet north of the monster well drilled in 1914, and its open-flow capacity was estimated at 100,000,000 to 125,000,000 cubic feet. Efforts to determine the rock pressure resulted in an estimate of 1,100 pounds to the square inch. The well was originally drilled to a depth of 3,130 feet in the quest for oil, the productive gas sand, encountered at a depth of about 2,200 feet, having been successfully sealed by the use of mud-laden fluid. Failing to find oil, the company decided to develop the gas, and, after all reasonable precautions had been taken to complete the well under control, bailing was commenced. Subsequent develop-

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ments are described as follows by the Fuel Oil Journal, issue of February, 1916:

While the open hole was being bailed the gas came with a rush and a roar, destroying the derrick in 20 minutes. Before the well was capped, the first week in January, the escaping gas and water could be seen for a distance of 15 miles, and the roar could be heard many miles away.

The massive fittings, weighted down with tons of cement, held until Wednesday, January 12, when under the constant pressure they gave way, stripping the threads from the irons buckled into the cement and throwing off the gate-valve connections. The hole soon began spouting sand, mud, and water along with the gas. The friction of the solid particles cut through the casing, part of which was lifted out of the hole, the remainder dropping out of sight.

On Monday, January 17, the gas caught fire in some way, and, with the exception of brief intervals when the flow was choked off, has been burning fiercely. At this date the flames are leaping from 200 to 300 feet in the air and lighting up the surrounding country for miles. All vegetation within a half mile of the well has been killed, and the surrounding ground is covered with heavy coatings of mud and sand. A crater 150 feet in diameter has been formed, and the remains of the rig have been swallowed up in the seething mixture of mud, sand, water, and gas.

The gas found in this field is reported to be of good quality, sweet and dry, and highly suitable for domestic consumption. Its presence here in such vast quantities will undoubtedly lead to additional efforts toward its development.

Eight wells in the Crowther gas field, in the northeastern part of McMullen County, supply natural gas to consumers in the town of Crowther.

During the month of January, 1915, natural gas from oil wells in the Corsicana field was supplied, as in previous years, to consumers in Corsicana. Subsequently, however, consumers in this city were supplied with gas from the Mexia-Groesbeck district, and the local source was abandoned except for field use.

In practically all the oil fields in Texas more or less gas is utilized in drilling and pumping operations.

Natural-gas producers in Texas numbered 65 at the end of 1915, compared with 75 at the end of 1914, and active gas wells in this State increased from 197 to 203 during the year, 27 new gas wells having been completed and 21 exhausted wells abandoned.

CONSUMPTION.

Aside from the natural gas consumed in the towns of Atlanta, Bloomburg, Cass, Leigh, Marshall, and Texarkana, which is obtained from Louisiana and is accounted for in the statistics relating to the industry in that State, the quantity of natural gas consumed in Texas is equivalent to the quantity produced in the State.

Of the natural gas from Texas sources consumed in the State in 1915 about 38 per cent was distributed to domestic consumers at an average price of 37.7 cents per thousand cubic feet, 10 per cent was distributed to manufacturing plants at an average price of 6.5 cents per thousand, and the remaining 52 per cent was consumed in the generation of power in other industrial plants at an average price of 9.2 cents per thousand. Compared with average prices in 1914, those in 1915 were lower by 1.3 cents to domestic consumers and by

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2.1 cents to manufacturing plants, but higher by 0.4 cent to other industrial consumers.

The principal wholesale distributor of natural gas in Texas is the Lone Star Gas Co., which supplies gas, principally from the Petrolia district, to retail distributors serving domestic and industrial consumers in practically all the larger cities of north-central Texas as far south as Dallas and Fort Worth. Other distributors in northern Texas include the Henrietta Gas Co., supplying Henrietta; the Pioneer Natural Gas Co., serving Moran, Baird, Putnam, and Clyde directly and Albany, Abilene, and Cisco through retailing companies; and the Santa Anna Gas Co., supplying Santa Anna.

In central Texas gas is distributed from the Mexia-Groesbeck district by the Mexia Oil & Gas Co., supplying Mexia; the Texas Gas Co., supplying Waco and Mart through the Texas Power & Light Co. and the Mart Gas Co., respectively; the Driscoll Pipe Line Co., supplying Richland and Wortham; the Herring Oil & Gas Co., supplying Groesbeck and Tehuacana; the Texas Pipe Line & Gas Co., supplying Teague; and the North Texas Gas Co., supplying Corsicana.

Additional companies in central and southern Texas distributing gas from other sources include the Boston & Texas Corporation, supplying Crowther from the Crowther field; the Central Texas Gas Co., supplying Bangs from the Bangs field; and the Border Gas Co., supplying Laredo from the Reiser field.

At the end of 1915 a total of 60,063 consumers were utilizing natural gas from Texas sources.

Record of natural-gas industry in Texas, 1909–1915.

Year.	Number of producers.	Number of consumers.		Total value of gas produced.	Wells.		
		Domestic.	Industrial.		Drilled.		Productive Dec. 31.
					Gas.	Dry.	
1909	17	5,035	130	$127,008	7	6	38
1910	19	14,719	133	447,275	22	5	52
1911	29	22,972	303	1,014,945	19	14	69
1912	41	27,226	329	1,405,077	24	23	87
1913	50	37,350	393	2,073,823	43	29	126
1914	75	48,547	468	2,469,770	89	23	197
1915	65	59,386	677	2,593,873	27	30	203

IOWA.

The production of natural gas in Iowa in 1915 came from four shallow wells in Louisa County, where sufficient gas was obtained from deposits of glacial drift for lighting three dwellings. Two additional wells in this county, capable of gas production, were closed in during the year.

NORTH DAKOTA.

The natural-gas industry in North Dakota is centered in Bottineau County, where consumers in the municipality of Lansford are sup-

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plied with gas from a few artesian wells. Near Mohall, Renville County, other artesian wells, ranging from 170 to 300 feet in depth, furnish sufficient gas to supply one or two households each. In the southeastern part of the State natural gas in small quantities, utilized locally, accompanies water in a few artesian wells in Lamoure County.

Two new gas wells, both in Bottineau County, were drilled in North Dakota in 1915. Three wells were abandoned as far as their gas supply is concerned. At the end of 1915 there were 12 wells in the State from which gas was being utilized.

SOUTH DAKOTA.

The natural-gas situation in South Dakota remained essentially unchanged in 1915. The gas produced and utilized in this State accompanies artesian water in wells ranging from 1,250 to 1,675 feet in depth in Hughes, Potter, Stanley, and Sully counties. Aside from Pierre and Fort Pierre, where the gas from 5 wells is distributed to some 365 domestic and 4 industrial consumers, including the waterworks and the electric-light plant in the former city, the consumption of natural gas in South Dakota is restricted to isolated households, which derive their supplies from individual wells.

In Corson County a small flow of gas not commercially utilized in 1915 was obtained in a well drilled for water at St. Elizabeth's School at Wakpala.

MONTANA.

In Dawson County, Mont., the Eastern Montana Oil & Gas Co. continued its efforts to develop natural gas in sufficient quantity to supply the municipality of Glendive. Two gas wells were completed in 1915 at depths less than 1,000 feet. The rock pressure of the gas in these wells is reported to be 380 pounds to the square inch.

Near Havre, in Hill County, one well was completed by the Havre Natural Gas Co., in July, which, at a depth of 947 feet, yielded a flow of gas estimated at 10,000,000 cubic feet a day, open flow. The initial closed pressure of the gas in this well was about 490 pounds to the square inch. The flow of gas from this well, which is about 2 miles northeast of Havre, is much greater than that obtained in either of the two wells drilled in this locality in 1914. Concerning the latter wells Eugene Stebinger, who examined the Havre district in the later part of 1915, states as follows:[1]

> The well at the west end of Havre, near the brewery, was drilled to a depth of 1,380 feet. Gas was obtained at 900 feet and again at the bottom of the hole, but each flow was small. The gas at the bottom of the hole gave a closed pressure of 540 pounds after 36 hours. The well at the east end of Havre, at the race track, is 1,285 feet deep. It yielded some gas at 885 feet and a larger flow at the bottom, which was estimated to be less than 1,000,000 feet a day. The gas from the lower sand gave a maximum closed pressure of 540 pounds in 24 hours.

[1] Stebinger, Eugene, Possibilities of oil and gas in north-central Montana: U. S. Geol. Survey Bull. 641, p. 78, 1916 (Bull. 641–C).

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The character of the gas from the well completed in 1915 is shown in the following analysis:[1]

Analysis of natural gas from Havre, Mont.

[Analyst not known.]

Carbon monoxide (CO)	0.20
Methane (CH_4)	94.80
Nitrogen (N)	5.00
	100.00
Heating value per cubic foot (British thermal units)	897

The completion of this well in July removed all doubt as to the adequacy of the natural-gas supply in the vicinity of Havre, and shortly thereafter mains were laid from the wells to the city. Early in 1916 the distribution of natural gas in Havre was begun.

At the end of 1915 there were 5 wells in Montana capable of producing natural gas.

WYOMING.

The natural-gas industry in Wyoming is still in its infancy, its development being retarded by the absence of adequate markets in proximity to the areas of production. Although vast quantities of natural gas have been proved to exist in the strata that underlie the Byron, Buffalo Basin, and Oregon Basin fields, in the Bighorn Basin, no feasible project has yet been devised for the commercial utilization of more than negligible quantities of the gas available.

The year 1915 was one of notable advance in the natural-gas industry in Wyoming, the profitable production of gas in that year being 165 per cent greater than 1914. Although a moderate gain was recorded in the quantity of gas consumed for domestic purposes in the municipalities of Basin, Greybull, and Byron, the principal gain was in the quantity of gas utilized in field operations in the Greybull district, Big Horn County, and the Grass Creek district, Hot Springs County. No additional wells were drilled in the Buffalo Basin and Oregon Basin districts, on the west side of the Bighorn Basin, in 1915, and no efforts were made to utilize the gas from the wells previously drilled there, which remained capped at the end of the year.

The most important development in the natural-gas industry of Wyoming in 1915 took place in northern Big Horn County, in the Byron district, southwest of Cowley, where in September the Montana-Wyoming Oil Co. completed what was reported as the largest gas well ever drilled in Wyoming. The well is located on the ranch of J. H. Ne Velle, and was credited with an initial open-flow capacity estimated conservatively at 40,000,000 cubic feet of gas a day and a rock pressure of 700 pounds to the square inch. For several weeks this monster gas well ran wild, and it was not until November that the company succeeded in shutting it in. Before the close of the year gas from this well had been turned into the mains in Byron,

[1] Stebinger, Eugene, op. cit., p. 74.

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and early in 1916 work was started on a project to supply gas from this well to domestic and industrial consumers in the town of Lovell, 9 miles northeast of the field. At the close of 1915 a project to pipe gas from this field to Billings, Mont., 80 miles to the north, was under consideration.

Other gas wells of average capacity were completed in this district and capped for future use.

In the Spring Valley district, in Uinta County, sufficient gas is still obtained from the productive oil wells to operate the engines used in pumping the wells.

Distribution of natural gas in Wyoming is effected by the Big-horn Oil & Gas Co., which supplies the municipalities of Greybull and Basin, and by the Montana & Wyoming Oil Co., which supplies Byron.

Natural-gas producers in Wyoming numbered 17 at the end of 1915, and active gas wells increased in number from 35 at the beginning of 1915 to 41 at its end.

A total of 599 domestic and 10 industrial consumers were supplied with gas in Wyoming in 1915, compared with 543 domestic and 12 industrial consumers in 1914.

Statistics of the quantity and value of natural gas produced and consumed in Wyoming are combined with those of Colorado and Montana in order to avoid disclosing data furnished in confidence by individual producers.

COLORADO.

In November, 1914, the gas well operated by the Federal Gas Co. in the Boulder field, which had supplied a large number of gas consumers in the town of Boulder for several years, was lost by salt-water flooding, and in consequence the natural-gas industry of Colorado in 1915 was restricted to the satisfaction of local fuel needs in the Boulder and Florence oil fields and in households adjacent to the source of supply in Las Animas County. The quantity of gas profitably produced in Colorado in 1915 is estimated to have been 32 per cent less than in 1914.

In the De Beque district, Mesa County, efforts to bring the "spouter" well on the ranch of Myers Bros. under control were renewed, and in 1916 the well, which has been flowing gas and water since 1912, was finally capped, and plans were made to pipe the gas to De Beque, 1¼ miles to the southeast. The open-flow capacity of this well is estimated at 2,000,000 cubic feet of gas a day. Its owners, the Rifle-De Beque Oil & Gas Co., propose to drill additional wells in the vicinity.

In the San Luis Basin, in southern Colorado, a wildcat test drilled by the San Luis Valley Oil & Gas Co. near Mosca, Alamosa County, yielded a slight flow of inflammable gas of which no commercial use has been made.

A total of 16 wells, 10 of which were primarily oil wells, were producing natural gas to supply the needs of seven domestic and eight industrial consumers in Colorado at the end of 1915.

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CALIFORNIA.

PRODUCTION.

The year 1915 was one of continued expansion for the natural-gas industry in California. It is estimated that 21,891,035,000 cubic feet of natural gas was produced and utilized in this State in 1915. This quantity exceeded by 4,062,107,000 cubic feet, or 23 per cent, the output in 1914 and by 10,856,438,000 cubic feet, or 98 per cent, the output in 1913. As the potential supply of natural gas in California is far in excess of existing marketing facilities, statistics of gas produced in this State reflect merely the ability of the gas-distributing companies to supply the demand. The gain in production in 1915 was due in part to a considerable increase in the quantity of gas supplied for domestic consumption in the cities of southern California and in part to a decided increase in the quantity utilized in the manufacture of gasoline. As to source, the increase in 1915 came principally from the Midway field in northern Kern County, but in part from the Whittier-Fullerton district in Los Angeles and Orange counties.

The total market value of the gas profitably produced in California in 1915 was $4,069,004, and the average price per thousand cubic feet was 18.59 cents, a gain of $1,158,220, or 40 per cent, in market value and of 2.26 cents, or 14 per cent, in unit price, compared with 1914.

The principal source of natural gas in California is the Midway field, in which gas flows of large volume are obtained from wells along the Buena Vista Hills anticline. In this district the wells range in depth from 900 to 2,600 feet, and closed pressures range from 250 pounds to the square inch in the shallower wells to 650 pounds in the deeper ones. The natural gas produced for other than field use in this district is obtained from holdings of the Honolulu Consolidated Oil Co., Kern Trading & Oil Co., Standard Oil Co. of California, and Midway Gas Co. Since 1913 natural gas from the Buena Vista Hills has been supplied to consumers in Los Angeles and adjacent cities of southern California through the 12-inch transmission line of the Midway Gas Co. that extends from Taft to Glendale, a distance of 107 miles. Gas from this source is also piped to Bakersfield, Maricopa, Taft, and Fellows, in San Joaquin Valley.

A considerable quantity of unmetered gas is obtained from oil wells in the Midway, Sunset, McKittrick, and Coalinga districts and consumed for field purposes on the leases where it is produced.

In southern California gratifying interest has been taken in the development of the vast resources of natural gas in the Whittier-Fullerton district. After many years of neglect, during which billions of cubic feet of natural gas have been wasted, steps were taken in 1915 toward the utilization of such stores of gas as remain. Concerning the waste of gas in this district and the progress made in the closing months of 1915 toward its abatement, Gilman[1] says:

[1] Away up in the Coyote Hills, access to which is made over a tortuous road leading to the summits through the Standard's camp, one beholds lying back in

[1] Gilman, C. H., Los Angeles gas: Oil City Derrick, Oct. 20, 1915.

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an immense basin, surrounded on all sides by hills, a large standing pipe, projecting into the air, which is fed at the bottom by laterals conveying the immense volume of natural gas that is allowed to go to waste. This gas the company has no use for, and it has been allowed to burn for a number of years, its great light illuminating the country at nighttime for many miles away.

Some time since the Southern California Gas Co. entered into negotiations with the Standaard Oil Co. for some of this waste gas, and an 8-inch pipe line is now being laid, which will be capable of bringing into the city some 15,000,000 cubic feet of gas daily. This line is being constructed on the same plan adopted by the Economic Gas Co., which is now handling virtually all the surplus gas from the old Salt Lake oil field, that is, with welded joints, which appear to be the most economical and in fact the most successful method of pipe jointing adopted in later-day pipe-line construction. * * *

The Fullerton district is about 18 miles from this city, and there is no question about the supply now available here, as previous to the last big gasser, which was locally reported as making 58,000,000 cubic feet, but is in reality making about 45,000,000 feet, there was something like 38,000,000 cubic feet available.

Prior to the advent of the Southern Counties Gas Co. as a purchaser of gas in the Whittier-Fullerton district, the only distributors of gas from this source were Murphy & Dillon, who supply the gas consumed in Fullerton, Placentia, Anaheim, Orange, Santa Ana, Tustin, and Orange Grove, and the Standard Oil Co. of California, which supplies this fuel to its refinery at El Segundo. Aside from this distribution a considerable volume of gas was utilized by individual companies in field camps and in drilling operations and some was absorbed in the local casing-head gasoline industry. The total consumption, however, was insignificant compared with the waste.

Additional progress in the conservation of the gas resources of southern California was recorded by the action, in July, of the Economic Gas Co. in substituting gas from the Salt Lake-Sherman district, 7 miles west of Los Angeles, for that obtained formerly from Kern County through the transmission line of the Midway Gas Co.

The discovery in 1915 of natural gas in a wildcat well drilled for oil near Chatsworth, in the northwestern part of Los Angeles County, aroused considerable speculation as to the possible development of a gas field at the west end of San Fernando Valley. This well was drilled by the Placerita Oil Co. and was completed in July, at a reported depth of 2,430 feet, as a gas well, with a capacity estimated at 2,000,000 cubic feet a day. The discovery well was capped, and to the end of 1915 no disposition of its product had been made. A gas field in this locality would be of considerable importance, as there are a number of small towns in San Fernando Valley in which its product could be marketed at small expense and the larger markets in Pasadena and Los Angeles are only 25 to 30 miles distant.

In the Santa Maria district, in Santa Barbara County, a sufficient quantity of natural gas is obtained from oil wells to support a thriving gasoline industry and to supply more than 1,100 domestic consumers in Santa Maria, Betteravia, Guadalupe, Nipomo, Arroyo Grande, and Orcutt. Consumers in Summerland are supplied with gas from abandoned oil wells in the old Summerland field.

In the oil fields of the Santa Clara River valley, in Ventura County, natural gas is obtained in sufficient quantities for field operations, for the manufacture of gasoline, and for mixing with artificial gas to supply consumers in Ventura, Santa Paula, and Oxnard.

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In the old Sargent or Watsonville field, in Santa Clara County, gas from oil wells is utilized as fuel for field operations.

Natural gas that accompanies water in many wells in Sacramento and San Joaquin counties is collected and distributed to a large number of domestic consumers in Sacramento, Stockton, and Lodi. The following analysis of gas from water wells in San Joaquin County was furnished by the Western States Gas & Electric Co., Stockton, Cal.:

Analysis of gas from San Joaquin County, Cal.

Methane (CH_4)	73.5
Carbon monoxide (CO)	.4
Carbon dioxide (CO_2)	.6
Oxygen (O)	.2
Nitrogen (N)	25.3
	100.00

In Solano County a single well at Fairfield produces sufficient gas to supply the needs of domestic consumers in the towns of Fairfield, Suisun, and Cement.

In Humboldt County, in the northern part of California, natural gas utilized in the town of Briceland is obtained from one well that is reported to have been producing for more than 20 years.

CONSUMPTION.

Of the natural gas produced and consumed in California in 1915 about 4,210,915,000 cubic feet, or 19 per cent, was distributed to domestic consumers, and 81 per cent was distributed to industrial consumers or utilized in the manufacture of gasoline. The market value of the gas distributed to domestic consumers amounted, however, to 69 per cent of the total value of the gas consumed in the State in 1915. The average price paid for gas by domestic consumers was 66.7 cents a thousand cubic feet, and by industrial consumers and gasoline plants was 7.1 cents a thousand, compared with averages of 61.1 cents for domestic gas and 7.5 cents for industrial gas in 1914.

Compared with prices paid for gas in the Eastern States, the average price paid by domestic consumers in California is exceptionally high. It is controlled by the price paid in Los Angeles and adjacent cities, as the greater part of the gas supplied for domestic consumption in this State goes to consumers in the Los Angeles district. Here a price of 64.5 cents, reduced from 68 cents during 1915, is fixed by the board of public utilities for a mixture of natural and artificial gas that must fulfill certain specific requirements as to heating value.

The number of domestic consumers of natural gas in California increased only 1 per cent in 1915, compared with 1914, whereas the number of industrial consumers increased 49 per cent.

As already indicated, the principal wholesale distributor of natural gas in California is the Midway Gas Co., which supplies gas from the Buena Vista Hills, Kern County, to retail distributors, including the Southern California Gas Co., the Los Angeles Gas & Electric Corporation, the Long Beach Consolidated Gas Co., the

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Southern California Edison Co., and the Western Fuel & Power Co. These companies mix the natural gas with equal proportions of artificial gas and distribute the mixture to customers in Los Angeles and its environs.

As the result of a reorganization in 1915 the Midway Gas. Co. acquired the properties of the Northern Exploration Co., a gas-producing company operating in the Midway field, and of the Southern California Gas Co., a retail distributor of gas in Los Angeles.

Another wholesale distributor of gas produced in the Midway field is the California Natural Gas Co., which supplies the product retailed by the Bakersfield Gas & Electric Co. in Bakersfield and vicinity, by the West Side Gas Co. in Maricopa and Taft, and by Joseph McDonald in South Taft and Fellows.

In the southern California district natural gas from the Salt Lake-Sherman field is supplied to consumers in Los Angeles by the Economic Gas Co., and from the Whittier-Fullerton field to consumers in Fullerton, Santa Ana, and adjacent towns by the Southern Counties Gas Co.

In the coastal district gas from the Santa Maria field is distributed to consumers in Santa Maria and adjacent towns by the Santa Maria Gas & Power Co., and from the Ventura County fields to consumers in Ventura, Santa Paula, and Oxnard by the Ventura County Power Co.

Gas from water wells is distributed to consumers in Sacramento and Lodi by the Sacramento Gas Co., and to consumers in Stockton by the Central Natural Gas Co. and the Western States Gas & Electric Co.

Record of natural-gas industry in California, 1909–1915.

Year.	Number of producers.	Number of consumers.		Total value of gas produced.	Wells.		
		Domestic.	Industrial.		Drilled.		Productive Dec. 31.
					Gas.	Dry.	
1909	35	7,612	104	$446,933	7	.....	[a] 64
1910	30	8,292	217	476,697	3	2	[a] 65
1911	32	10,598	207	800,714	8	6	[a] 66
1912	43	18,171	232	1,134,456	6	1	[a] 71
1913	48	[b] 164,358	141	1,883,450	9	4	[a] 72
1914	57	[b] 205,163	172	2,910,784	8	1	[a] 75
1915	59	[b] 207,673	257	4,069,004	2	2	[a] 72

[a] Includes some artesian wells from which gas was used.
[b] Includes some consumers who are using mixed gas.

OREGON.

Sufficient gas to provide lights for two households is furnished by a well drilled for oil several years ago at Ontario, Malheur County, Oreg.

WASHINGTON.

Natural gas is not produced commercially in the State of Washington. A 700-foot well drilled near Benton City, Benton County, is reported to be capable of producing 300,000 cubic feet of gas a day.

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NATURAL GAS IN FOREIGN COUNTRIES.

CANADA.

The preliminary report on the mineral production of Canada in 1915, issued by the Department of Mines, Mines Branch, contains the following summary of natural-gas production and of gas-field development in Canada:

Complete returns have not yet been received from some of the largest operators in Ontario. The 1915 production of natural gas, therefore (subject to corrections of the estimates used), was approximately 18,319,710,000 cubic feet, valued at $3,300,825, contributed by Provinces as follows: Ontario, 13,510,071,000 cubic feet, valued at $2,202,523; New Brunswick, 430,692,000 cubic feet, valued at $60,383; and Alberta, 4,378,947,000 cubic feet, valued at $1,037,919.

The production the previous year was reported as 21,692,504,000 cubic feet, valued at $3,484,727, of which amount Ontario produced 14,094,521,000 cubic feet, valued at $2,215,808; New Brunswick, 425,826,000 cubic feet, valued at $54,249; and Alberta, 7,172,157,000 cubic feet, valued at $1,214,670.

Ontario's production in 1915 showed a decrease of 584,450,000 cubic feet; Alberta production, a decrease of 2,793,210,000 cubic feet; and New Brunswick production, an increase of 4,866,000 cubic feet.

The Ontario gas production came from the same fields in the southern portion of the Province between Niagara Falls and Windsor, as heretofore. In 1914 and 1915 gas from the Kent fields was distributed as far east as Hamilton, a distance of 153 miles.

The New Brunswick production is obtained in Albert County and supplies chiefly Hillsborough and Moncton, while in Alberta, Medicine Hat and Bow Island are still the principal gas fields being utilized, supplying the district between Medicine Hat and Calgary.

Value of natural gas produced in Canada, 1909–1915.

Year.	New Brunswick.	Alberta.	Ontario.	Total Canada.
1909	.....	$61,722	$1,145,307	$1,207,029
1910	.....	75,168	1,271,303	1,346,471
1911	.....	110,165	1,807,513	1,917,678
1912	$36,549	289,906	2,036,245	2,362,700
1913	174,147	1,079,466	2,055,768	3,309,381
1914	54,249	1,250,320	2,346,687	3,651,256
1915	[a] 60,383	[a] 1,037,919	2,622,838	(a)

[a] Returns incomplete.

Statistics of natural gas in the Province of Ontario, Canada, 1909–1915.

Year.	Wells bored in the year.		Producing wells Dec. 31.	Miles of gas pipe.	Workmen employed.	Gas produced.		Wages for labor.
	Productive	Non-productive				Quantity (cubic feet).	Value.	
1909	.....	.....	744	987	171	5,388,000,000	$1,145,307	$103,672
1910	.....	.....	828	982	186	7,263,427,000	1,271,303	118,785
1911	268	38	1,179	1,296	287	10,863,871,000	1,807,513	183,663
1912	178	41	1,247	1,448	277	12,529,463,000	2,036,245	184,351
1913	166	48	1,522	1,720	402	12,474,745,000	2,055,768	289,480
1914	108	18	1,550	1,380	479	14,063,000,000	2,346,687	256,139
1915	109	13	1,734	1,931	598	15,211,500,000	2,622,838	382,401

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The following extracts from a paper by Bosworth[1] show the present status of natural-gas development in the Province of Alberta:

The natural gas of Alberta occurs in the Cretaceous formation—a formation which occupies all but a small part of the Province. The principal gas sands are in the Dakota series and in the Belly River series of the formation. Both these series are sheets of sandy sediment of variable character and thickness, and in some places discontinuous or represented only by clays and shales. * * *

The fields of economic importance now proved are in four regions having particular geological structures, as follows:

1. The Sweetgrass anticlinal of southeastern Alberta.
2. The Battle River anticlinal of eastern Alberta.
3. The foothill region of southwestern Alberta.
4. The Athabasca monoclinal of northern Alberta. * * *

In the southeast of the Province the strata have been slightly upraised by a very gentle fold. This anticlinal is wide and of great extent, with its axis trending from northwest to southeast, passing through the Bow Island district and thence through the Sweetgrass Hills into Montana.

An immense quantity of gas is accumulated in the sands in this anticlinal, and already a large amount has been released, although only a very small fraction of the productive area has yet been touched. At two localities—Bow Island and Medicine Hat—a heavy daily production is now obtained. * * *

The Bow Island field was developed in 1912 and the subsequent years to supply the city of Calgary, and the scheme has been in operation now for three complete years and has proved a conspicuous success. The gas is conveyed to Calgary by a 16-inch pipe line over a distance of 171 miles, with branch lines supplying the smaller towns of Lethbridge, Macleod, Granum, Claresholm, Okotoks, Sandstone, etc. In Calgary (population 75,000) the natural gas is generally used in the heating and lighting of both public and private buildings, and also as fuel in generating the electric supply. The average daily consumption in Calgary is about 10,000,000 cubic feet, of which 30 per cent is for industrial use. Some 17 wells at Bow Island have been drilled to maintain this supply, but only 2 of them are allowed to flow at a time, as a rule. The depth of the wells is about 2,000 feet, and the production is obtained from the Dakota sands. All of these wells are large producers; in fact, they are amongst the largest gas wells in the world. Some have yielded as much as 20,000,000 or 30,000,000 cubic feet in a day. The pressure also is unusually high, being 795 pounds per square inch when the well is closed, and up to the present time there is no sign of diminution. * * *

The Medicine Hat field was developed to supply the city of Medicine Hat and various industrial concerns in the neighborhood. There are now about 25 wells within or near the city limits. The wells are from 1,000 to 1,300 feet deep and yield from sands which are supposed to belong to the Belly River series. Each well can produce from 2,000,000 to 4,000,000 cubic feet per day (open flow), and there is a pressure (closed) of about 600 pounds. * * *

The population of the city is about 15,000, and most of the gas wells are owned by the municipality, the gas being supplied at the low rate of 15 cents per 1,000 for domestic use and 5 cents for industrial use. Also there is a rebate of 1½ cents on prompt payment. In addition to this, some large amounts of gas are disposed of without price, and some industrial concerns possess wells of their own. * * *

The small town of Redcliff also is abundantly supplied with gas from its own little gas field, situated on this Sweetgrass anticlinal, and a number of other small towns within the region now have their own gas wells or are preparing to drill them.

Practically no limits have yet been determined for the gas territory of the Sweetgrass anticlinal. During 1915 some wells were drilled in search of oil on the southern extension of this anticlinal, in the Sweetgrass Hills, near the international boundary line, and in these wells also the same dry gas was found. Thus in the United Well No. 3, 31 miles south from Bow Island, a flow of 18,000,000 cubic feet per day was reported. Over the boundary, in Montana, also, a continuation of the gas fields has been proved during the past year. * * *

[1] Bosworth, T. O., The gas fields of Alberta; Petroleum World, vol. 13, No. 187, pp. 163–166, April, 1916.

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In the Battle River region of eastern Alberta we have another extensive, though gentle, anticlinal, similar and parallel to the Sweetgrass anticlinal above described. The axis lies some 70 miles east of Edmonton and passes southeastward into Saskatchewan.

One deep well (2,340 feet) was drilled on the west flank of the anticline, at Viking, 80 miles southeast of Edmonton, and at the close of 1914 a flow of gas, estimated at 4,000,000 feet per day, had been obtained. The initial pressure was about 500 pounds. It is proposed to supply gas to Edmonton from this field. * * *

In the foothill region of southwestern Alberta the strata are sharply folded, overfolded, and faulted, and the sands of the Dakota and Belly River series frequently crop out. Seepages of gas are fairly common, and there are four very large gas springs in the Sheep Creek, the High River, and neighboring valleys.

It is on the site of one of these springs that the Dingman well was drilled, in which was found the remarkable light oil that led to the Calgary boom. Some 50 wells have been drilled in the foothill country, and large quantities of gas were found in many of them. In the Dingman well it is claimed that there is a gas supply of 12,000,000 cubic feet per day. This gas has been used as fuel in the drilling field.

At first it was stated that there was a heavy content of gasoline in the Dingman gas, and a small plant was set up to attempt to extract it. The experiment, however, did not develop into any commercial success.

There is now a project to pipe the gas to Calgary to supply such parts of that city as lie outside the area for which the franchise has already been bestowed. * * *

In the northern part of Alberta the Cretaceous formation is well exposed for several hundred miles along the valley of the Athabasca. The most northern outcrops are those of the Dakota sands, here known as the tar sands, described by the writer in the Petroleum World of January, 1915. * * *

In this northern part of the country, between the outcrop of the tar sand and Edmonton, a number of wells have been drilled, and the evidence from them points to the presence of large accumulations of gas in these particular representatives of the Dakota series. Only a few of the wells have been drilled right down to reach the tar sand, and in each of these important flows of gas were found. Those which did not get down to this sand generally found some smaller quantities of gas in the various other sands and shales above.

The most interesting of the wells in this region was that drilled for the Government at Pelican Rapids, 1897–98, 50 miles from the outcrop of the tar sand. Strong flows of gas were struck at 750 and 773 feet, and at 820 feet there was a tremendous flow, the roaring of which could be heard at a distance of 3 miles or more. No progress could be made until the second year, but even then the depth could only be carried down to 837 feet on account of the tar being forced up by the gas and clogging up the tools. There are no figures as to the original pressure and quantity of the gas. When visited by the writer in 1914 gas was still flowing from the well and was being used as fuel for the drilling of new wells near by.

ITALY.

The Rivista del servizio minerario gives the following statistics:

Natural gas produced in Italy, 1909–1915.

Year.	Quantity (cubic meters).	Value.	Year.	Quantity (cubic meters).	Value.
1909	8,268,000	$42,287	1913	6,015,000	$48,974
1910	8,840,000	73,301	1914	5,920,000	48,479
1911	9,021,000	74,174	1915	(a)	(a)
1912	6,800,000	57,128			

a Not available.

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UNITED KINGDOM.

The following statistics are taken from the annual report of the British Home Office:

Natural gas produced at Heathfield, Sussex County, England, 1909–1915.

Year.	Quantity (cubic feet).	Value.	Year.	Quantity (cubic feet).	Value.
1909	236,800	(a)	1913	87,450	(a)
1910	262,000	(a)	1914	87,000	(a)
1911	221,400	(a)	1915	(b)	(b)
1912	161,200	(a)			

a Not stated. b Not available.

HUNGARY.

A corporation, called the Hungarian Natural Gas Co., is reported[1] to have been formed at Budapest to take charge of the execution of contracts made between the Hungarian Minister of Finance and a group of capitalists headed by the Deutsche Bank of Berlin for the exploitation of certain deposits of natural gas in Hungary. The capital of the new corporation has been fixed at 27,000,000 kronen, of which 4,000,000 kronen is said to have been pledged to the Hungarian Minister of Finance in return for the transfer of the State lands to the corporation. The Deutsche Bank is understood to have contributed 30 per cent of the authorized capital. Several contracts are reported to have been made by the new corporation for the supply of natural gas to various enterprises and an extensive campaign of development is to be undertaken at the termination of the European war.

The area to be developed lies in the vicinity of Siebenburg, in Transylvania, where the presence of natural gas has long been known, though the magnitude of the supply available was not suspected until 1909, when in the course of prospecting for potassium salts near Kissarmas a gas well yielding a daily flow of 30,000,000 cubic feet of gas containing 99 per cent methane was brought in.

Subsequently a number of successful gas wells were completed and capped in the marshy district near Kissarmas, and for a time the only use made of the gas was for lighting railway cars, for which it was supplied in steel cylinders. In April, 1914, a pipe line 45 miles long was completed from the field to Torda (Thorenburg), the nearest manufacturing center, and distribution of gas was begun to domestic and to industrial consumers, the latter including an electrochemical plant, a cement plant, and a brick plant. Official estimates place the capacity of the wells shut in in the Kissarmas district at approximately 85,000,000 cubic feet of gas a day.

GASOLINE FROM NATURAL GAS.

GENERAL STATEMENT.

The steady annual increase in gasoline production that has characterized the growth of the casing head gasoline industry in the United States during the last five years was fully maintained in 1915. In

[1] Petroleum Review, July 22, 1916.

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that year the quantity of raw gasoline extracted from natural gas and sold in this country amounted to 65,364,665 gallons, a quantity greater by 22,712,033 gallons, or 53 per cent, than the record output in 1914 and greater by 41,303,848 gallons, or 172 per cent, than the output in 1913.

The phenomenal growth of this industry, as indicated by the foregoing statistics, has been in response to the rapidly increasing demand for motor fuel in the United States and elsewhere that has

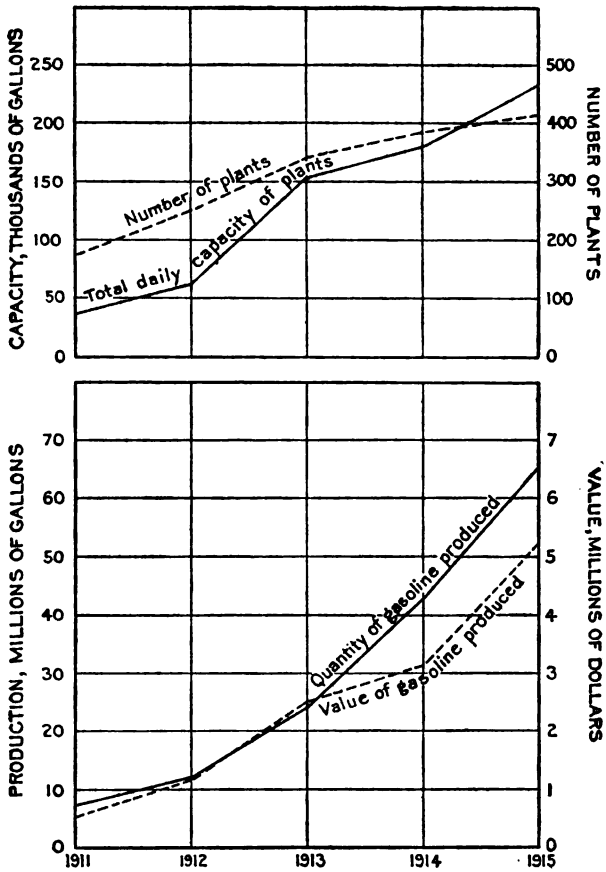

FIGURE 31.—Number and capacity of plants producing gasoline from natural gas and quantity and value of gasoline produced in the United States, 1911–1915.

resulted primarily from the rapid expansion of the automobile industry, particularly since the development of efficient cars that sell for moderate prices.

As a factor in the total production of gasoline in the United States the contribution of the casing head gasoline industry is of relatively slight though increasing importance. According to statistics compiled by the Bureau of the Census[1] the total quantity of gasoline produced in the United States in 1914 was 1,235,578,250 gallons, of

[1] Census Bur. Press Bull., Feb. 10, 1916.

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which 42,652,650 gallons, or about 3.5 per cent, was extracted from natural gas. According to estimates prepared by the Federal Trade Commission [1] the total gasoline content of the crude petroleum produced in the United States in 1915 was in excess of 1,892,500,000 gallons. Addition to this of the computed output in 1915 of natural-gas gasoline gives a total of 1,977,900,000 gallons as the approximate quantity of gasoline available in that year. Of this quantity the output of the casing head gasoline plants represented about 3.3 per cent. This comparison of the quantity of unblended gasoline extracted from natural gas with that of the commercial product from petroleum refineries is not wholly fair to the casing head gasoline industry, as the quantity of commercial gasoline obtained by blending the raw casing head product with refinery naphtha is from 30 to 50 per cent greater than the quantity of raw gasoline involved. In the absence of statistics on this subject it is impossible to approximate the quantity of commercial gasoline made from the high-gravity condensate, as blending practice varies widely in different States and in different plants in the same State and as there is an increasing tendency in certain localities to mix the condensate from natural gas with crude oil and to recover it as straight-run gasoline in the refinery.

The accompanying diagrams (fig. 31) show graphically the remarkable growth of the casing head gasoline industry in the United States since 1911, the first year for which authoritative statistics are available.

The average price received in 1915 for unblended gasoline at the sources of production was 7.9 cents a gallon and the market value of the entire output was $5,150,823, a gain of 0.6 cent in average unit price and of $2,044,914, or 66 per cent, in total market value, compared with 1914. The extraordinary advance in price that featured the retail market for commercial gasoline in the United States during the last half of 1915 came too late in the year to affect materially the average price of condensate at the casing head gasoline plants, but the influence of the high-level market for gasoline to which these advances subsequently led should be strongly reflected in the average price of condensate at the plant in 1916, as well as in statistics of gasoline produced and of new plants installed.

The following table [2] shows for two important areas of gasoline consumption the wholesale price of commercial gasoline each month of 1915. The price to consumers averaged 1 cent higher than that to dealers.

[1] Investigation of the price of gasoline (letter from the chairman of the Federal Trade Commission transmitting a preliminary report relative to an investigation of gasoline prices by the commission): S. Doc. 408, p. 10, 1916.
[2] Idem, p. 14.

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Comparison of average monthly tank-wagon prices[a] of gasoline (58°–60°) in the East (Pennsylvania) with those in the West (North Central States), 1915.

[Cents per gallon.]

Month.	East (Pennsylvania), Atlantic Refining Co. (Standard).	West (North Central States).	
		Standard companies.	Other companies.
January	10.00	11.69	11.15
February	10.00	10.95	10.92
March	9.86	10.57	10.64
April	9.86	10.57	10.43
May	9.86	10.57	10.38
June	9.86	9.84	9.72
July	9.86	9.61	9.50
August	10.38	9.61	9.50
September	12.23	10.21	10.35
October	12.86	11.85	11.93
November	14.29	13.45	13.64
December	16.28	15.30	15.62

[a] The "tank-wagon prices" referred to are the wholesale prices charged dealers for gasoline delivered in bulk by tank wagon. They are computed for gasoline having the same gravity according to the Baumé test (58°–60°). As freight and marketing costs are included, the figures are not comparable on an absolute basis, but are chiefly valuable as indicating the movement of prices.

At the end of 1915 there were 414 plants for the extraction of gasoline from natural gas in actual operation in the United States, a net gain of 28 plants during the year. The principal gain was in Pennsylvania, where the net increase was 20 plants. During 1915 experimental plants were installed in the Electra field, Wichita County, Tex., and in the Caddo district, in northwestern Louisiana. The daily capacity of all gasoline plants increased from 179,353 gallons at the end of 1914 to 232,336 gallons at the end of 1915, a gain of 30 per cent that is accounted for in part by a 7 per cent increase in the number of new plants and in part by the fact that many of the plants in operation at the end of 1914 operated during only a part of that year. On the basis of 300 working days, the actual average output of casing-head gasoline in 1915 was 217,882 gallons a day.

The volume of casing-head gas utilized in the production of gasoline in 1915 is estimated to have amounted to 24,064,391,000 cubic feet, about 4 per cent of the total volume of gas produced and consumed in the United States in that year. The total market value of that gas is estimated at $1,202,555, an average price of 5 cents a thousand cubic feet.

Exclusive of the volume of gas involved in the formation of drips in gas mains, which is not subject to estimation, the average recovery of gasoline per thousand cubic feet of gas utilized was 2.57 gallons in 1915. Compared with the recovery in 1914, the average in 1915 shows a gain of 0.14 gallon for each thousand feet of gas treated, which is accounted for principally by increased efficiency in plant operation, but in part by the normal increase in gasoline content of casing-head gas that takes place with the increasing age of the source from which it is derived. The highest average recovery reported in 1915 was 8 gallons per thousand cubic feet from a plant that utilizes gas from the Glenn pool in Oklahoma; the lowest was 0.30 gallon from a plant in Kanawha County, in West Virginia.

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A complete description of the methods employed in the manufacture of casing-head gasoline and a discussion of the tests to determine whether or not sufficient gasoline is present in a given type of natural gas to warrant the installation of a plant for its recovery is contained in Bureau of Mines Bulletin 88, "The condensation of gasoline from natural gas," issued in 1915.

THE ABSORPTION PROCESS.

A noteworthy development of the last two years in the casing-head gasoline industry is the absorption process, which provides a means of recovering gasoline from types of gas too lean in gasoline content to warrant treatment by compression and condensation methods. The principles, methods, and possibilities of this process are ably set forth in the following summary of a more detailed discussion of this subject by Burrell,[1] in a paper read before the Natural Gas Association of America, Pittsburgh, Pa., May 15, 1916:

The absorption method of extracting gasoline from natural gas consists in bringing natural gas in contact with an oil heavier than gasoline—that is, a petroleum distillate of about 34° Baumé, letting the absorbent absorb the gasoline from the natural gas, and then separating the gasoline from the oil by distillation. The oil is simply used as a carrier of the gasoline from the absorption tank to the still. It is used over and over again.

This method is different from the extraction of gasoline from casing head natural gases by compression and condensation methods. By the latter method natural gases that are comparatively rich in gasoline vapor are treated—that is, those carrying upward of three-fourths gallon of gasoline per 1,000 cubic feet of natural gas. So-called "dry" natural gas can not be treated by this method. By "dry" natural gases are meant those used in cities, towns, and factories for heating, lighting, and other purposes. The quantity consumed of this kind of natural gas amounted in 1914 to 591,000,000,000 cubic feet. Most of this natural gas carries gasoline to the extent of 1 to 2 pints per 1,000 cubic feet of gas. Probably 75,000,000 gallons of gasoline per year can be obtained by treating much of this natural gas at the present time.

In the case of two natural gases that the authors of this paper experimented with, the heating value was only lowered 3.8 per cent in one case and 2.2 per cent in another case by the extraction of the gasoline.

Besides the obtaining of valuable fuel, gasoline, a further advantage of the process lies in the resultant protection of pipe lines against the deteriorating effect of gasoline on coupling rubbers. The replacing of these rubbers and the repairing of broken connections and loss of natural gas thereof has been a large item of expense in gas transportation companies' operating costs.

The absorption process of extracting gasoline from natural gas assumed industrial importance as the demand for gasoline increased. The scheme is practically identical with the process of extracting benzol and toluol (light oil) from coke-oven gases, a process used for years in Germany and to a very large extent during the years 1915 and 1916 in the United States. A difference lies in the fact that coke-oven gases are treated at about atmospheric pressure, while natural gas is treated at pressure as high as 200 to 300 pounds per square inch. This is an economic necessity because natural gas is transported at high pressure, and it is not desirable to disturb the system.

To the best of the authors' knowledge the first large-scale installation for extracting gasoline from natural gas by the absorption process was placed at Hastings, W. Va., by the Hope Natural Gas Co., of Pittsburgh, Pa. Operations commenced in 1913. The plant was built following experiments by George M. Saybolt.

[1] Burrell, G. A., Biddison, P. M., and Oberfell, G. G., The extraction of gasoline from natural gas by absorption methods: Met. and Chem. Eng., vol. 14, No. 11, pp. 651–660, June 1, 1916.

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Natural gas can be tested as regards the practicability of extracting gasoline from it by absorption process by two methods. One is a laboratory method whereby the gasoline is frozen out of the natural gas and its pressure and volume determined. The other method is a field method.

A small absorber and a gas meter can be taken to the well or pipe line to be tested for natural gas, the gas passed through the absorbent, and the extracted gasoline distilled from the oil; in other words, a duplicate on a small scale of the commercial method.

All natural gases, except those that contain methane only as the combustible gas, contain gasoline vapor. However, in some cases the amount contained may be very small. This is sometimes due to the fact that gas wells are under very high pressures, and this high pressure keeps the gasoline back in the well. But even those high-pressure wells represent potential sources of gasoline supply in that natural gas will carry commercial quantities of gasoline vapor as the pressure declines.

Natural gas from two different fields that the authors tested contained gasoline to the extent of 1 pint per 1,000 cubic feet in one case and 1.5 pints in another case. About 50,000,000 cubic feet of natural gas per day was available for treatment.

Oils which the authors experimented with to act as absorbents for the gasoline were about 35° Baumé specific gravity and started to boil at about 400° to 462° Fahrenheit. They were petroleum distillates. It is necessary that their boiling point be much higher than the boiling point of gasoline to make the extraction of the latter by distillation easy.

Tests were made on a plant of fairly large proportions, capable of handling 15,000 to 30,000 cubic feet of gas per hour. The plant consisted of an absorber, where the natural gas and absorbent oil were brought in contact with each other; a heat exchanger, where the oil with its absorbed gasoline was heated before going to the still where the gasoline was extracted from the oil; a cooler, where the hot oil from the still was cooled before receiving another charge of gasoline; pumps, weathering tank, etc.

Several different types of absorbers were tried. The one giving the best results consisted of a stone tower down which the oil flowed and up which the gas passed.

An increase in the temperature of the oil in the absorber from about 75° to about 85° Fahrenheit lowered the gasoline yield about 0.3 pint per 1,000 cubic feet of gas. An increase in the pressure of the gas from atmospheric pressure to 110 pounds per square inch increased the yield from 0.7 pint to about 1.9 pints of gasoline per 1,000 cubic feet of gas.

The specific gravity of the gasoline obtained varied between 77° and 85° Baumé. The boiling points ranged from 80° to 300° Fahrenheit. The evaporation loss was about 11 per cent in 24 hours as compared to straight refinery gasoline 60.4° Baumé, having an evaporation loss of about 2.4 per cent in 24 hours. The vapor pressure of the gasoline ranged from 1 pound at 70° Fahrenheit to about 5 pounds at 100° Fahrenheit. This is important because it shows that the gasoline can be shipped in tank cars.

Some tests were made in which the natural gas was simply passed into a naphtha of about 55° Baumé. When the naphtha had absorbed all the gasoline that was desired it was removed and fresh naphtha substituted. By this scheme there were obtained yields of gasoline varying between 300 and 500 per cent greater than that by the oil absorption and distillation process. In some cases the naphtha, besides being increased in volume due to the absorbed gasoline, was raised in specific gravity to 60° or 62° Baumé. An objection to the process lies in the fact that a large amount of naphtha has to be handled—at least seven tanks of naphtha for each tank of gasoline obtained.

There are possibilities in the application of the absorption method of treating natural gas to the casing-head natural gas, much of which is treated at the present time by compression and condensation methods.

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MARKETED PRODUCTION.

Gasoline from natural gas marketed in the United States, 1911–1915.

1911.

State.	Number of operators.	Plants. Number.	Plants. Daily capacity.	Gasoline produced. Quantity.	Gasoline produced. Value.	Gasoline produced. Price per gallon.	Gas used. Estimated quantity.	Gas used. Value.	Average yield in gasoline per M cubic feet.
			Gallons.	*Gallons.*		*Cents.*	*Cubic feet.*		*Gallons.*
West Virginia	47	72	16,819	3,660,165	$262,661	7.18	1,252,990,600	$76,674	2.92
Ohio	26	39	6,454	1,678,985	118,161	7.04	469,672,000	37,574	3.57
Pennsylvania	43	50	5,669	1,467,043	109,649	7.47	526,152,663	52,615	2.79
Oklahoma	8	8	4,800	388,058	20,975	5.40	144,630,000	4,576	2.68
California, Colorado, Illinois, New York, Kentucky	8	7	3,358	[a] 231,588	20,268	8.75	82,343,000	6,320	2.81
	132	176	37,160	7,425,839	531,704	7.16	2,475,697,263	176,961	3.00

1912.

State.	Number of operators.	Plants. Number.	Plants. Daily capacity.	Gasoline produced. Quantity.	Gasoline produced. Value.	Gasoline produced. Price per gallon.	Gas used. Estimated quantity.	Gas used. Value.	Average yield in gasoline per M cubic feet.
West Virginia	66	97	22,366	5,318,136	$513,116	9.6	1,972,882,212	$163,749	2.8
Pennsylvania	69	83	10,524	2,041,109	217,016	10.6	732,780,117	63,010	2.6
Ohio	25	43	7,791	1,718,719	173,421	10.1	576,123,700	46,090	2.98
Oklahoma	11	13	11,910	1,575,644	99,626	6.3	701,044,300	24,901	2.25
California	7	7	6,669	1,040,695	112,562	10.8	600,743,000	25,573	1.7
Illinois, Colorado, New York, Kentucky	9	8	2,008	[a] 396,876	41,795	10.8	114,273,000	9,662	3.4
	186	250	61,268	12,081,179	1,157,476	9.6	4,687,796,329	331,985	2.6

1913.

State.	Number of operators.	Plants. Number.	Plants. Daily capacity.	Gasoline produced. Quantity.	Gasoline produced. Value.	Gasoline produced. Price per gallon.	Gas used. Estimated quantity.	Gas used. Value.	Average yield in gasoline per M cubic feet.
West Virginia	66	115	31,930	7,662,493	$807,466	10.54	2,981,119,000	$181,337	2.57
Oklahoma	19	40	61,633	6,462,968	577,944	8.94	2,152,503,000	82,742	3.00
Pennsylvania	100	113	22,207	3,680,096	405,186	11.01	1,372,056,000	114,783	2.68
California	12	14	21,135	3,460,747	376,227	10.87	2,436,445,000	106,539	1.42
Ohio	25	41	8,142	2,072,687	212,404	10.26	744,236,000	63,233	2.79
Illinois, Colorado, New York, Kansas, Kentucky	13	18	7,368	[a] 721,826	79,276	10.98	203,092,500	17,590	3.55
	232	341	152,415	24,060,817	2,458,443	10.22	9,889,441,500	566,224	2.43

1914.

State.	Number of operators.	Plants. Number.	Plants. Daily capacity.	Gasoline produced. Quantity.	Gasoline produced. Value.	Gasoline produced. Price per gallon.	Gas used. Estimated quantity.	Gas used. Value.	Average yield in gasoline per M cubic feet.
Oklahoma	35	58	74,793	17,277,555	$1,113,059	6.44	5,788,549,000	$273,940	3.01
West Virginia	65	121	34,460	9,278,108	691,899	7.45	3,005,292,000	173,396	2.58
California	17	19	32,260	7,581,309	633,517	8.36	5,129,709,000	197,066	1.48
Pennsylvania	96	119	21,456	4,611,738	359,402	7.79	1,560,064,000	125,690	2.89
Ohio	25	47	9,319	2,440,171	184,097	7.54	852,277,000	68,935	2.86
Illinois	7	14	5,300	1,164,178	100,331	8.62	462,321,000	43,017	2.53
Kansas, New York, Colorado, Kentucky	9	9	1,665	[a] 299,573	23,604	7.88	146,345,000	8,862	2.03
	254	386	179,353	42,652,632	3,105,909	7.28	16,894,557,000	889,906	2.43

[a] Includes gasoline produced in Kentucky which came from natural condensation in gas mains.

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Gasoline from natural gas marketed in the United States, 1911–1915—Continued.

1915.

State.	Number of operators.	Plants.		Gasoline produced.			Gas used.		Average yield in gasoline per M cubic feet.
		Number.	Daily capacity.	Quantity.	Value.	Price per gallon.	Estimated quantity.	Value.	
			Gallons.	*Gallons.*		*Cents.*	*Cubic feet.*		*Gallons.*
Oklahoma	36	63	111,463	31,665,991	$2,361,029	7.46	8,791,881,000	$435,512	3.60
California	18	20	40,755	12,835,126	975,397	7.60	8,006,888,000	288,669	1.60
West Virginia [a]	66	114	34,422	10,853,608	927,079	8.54	3,526,575,000	150,918	2.30
Pennsylvania [a]	116	139	22,754	5,898,597	569,873	9.66	1,838,034,000	186,325	2.73
Ohio	29	50	8,995	2,198,715	167,138	7.60	785,041,000	77,767	2.80
Illinois	8	16	8,500	1,035,204	80,049	7.73	451,663,000	34,405	2.29
Texas	1	1							
New York	4	4							
Louisiana	2	2	5,447	877,424	70,258	8.01	664,309,000	28,959	1.32
Kansas	3	2							
Colorado	2	2							
Kentucky [a]	2	1							
	287	414	232,336	65,364,665	5,150,823	7.88	24,064,391,000	1,202,555	2.57

[a] Includes gasoline resulting from natural condensation in gas mains.

CASING HEAD GASOLINE INDUSTRY BY STATES.

OKLAHOMA.

The output of raw casing-head gasoline in Oklahoma in 1915, which amounted to 31,665,991 gallons, was more than sufficient to retain for this State its premier rank as a source of this material. Compared with the output of 1914, that in 1915 shows a gain of 14,388,436 gallons, or 83 per cent. Compared with the output of California, which ranked second in 1915, that of Oklahoma was greater by nearly 19,000,000 gallons, or about 147 per cent.

This remarkable increase in output is ascribed in part to a net increase of 5 in the number of contributing plants, but principally to the fact that the 18 plants installed during 1914 were in full operation throughout the whole of 1915. The reported capacity of the 63 plants in operation in Oklahoma at the end of 1915 was 111,463 gallons a day, whereas the average actual output during 1915, on the basis of 300 working days, was 105,553 gallons a day.

The total value of the production in 1915, before blending, was $2,361,029, or an average of 7.46 cents a gallon. Compared with corresponding statistics for 1914, these data show increase of $1,247,970, or 112 per cent, in the total value of the output in 1915, and 1.02 cents, or nearly 16 per cent, in the average price per gallon.

It is estimated that 8,971,881,000 cubic feet, representing 10 per cent of the total value of gas produced commercially in Oklahoma in 1915, was utilized in the manufacture of gasoline. From this volume of gas the average recovery of gasoline was 3.6 gallons to the thousand cubic feet, though the actual recovery showed a wide variation, depending on the source of the gas used and on the efficiency of plant operation. The richest source of casing-head gasoline thus far developed in Oklahoma, and in the entire United States for that matter,

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is the low-pressure gas derived from the Glenn pool in eastern Creek and southern Tulsa counties. In this district alone 25 plants were in operation during 1915, utilizing gas from which the average recovery of gasoline was between 3 and 4 gallons to the 1,000 cubic feet, though the range was from 0.5 gallon to 8.0 gallons a thousand.

The principal locality in Oklahoma in which the casing-head gasoline industry showed expansion in 1915 was the Cushing district in western Creek County. The number of plants operating was increased from 3 at the end of 1914 to 6 at the end of 1915. Outside the Cushing and Glenn districts, one plant is in operation in southern Creek County, at Mounds. In the Cherokee district the scarcity of gas resulted in a decrease in the number of plants at the end of 1915 in Nowata and Washington counties, the net loss being 3 plants during the year. Two new plants, 1 in each county, were installed in Okmulgee and Muskogee counties in 1915. As in 1914, 1 plant in Pawnee County manufactured gasoline from gas produced in the Cleveland district during 1915.

A tendency toward consolidation of interests and the centralization of control of the casing head gasoline industry in Oklahoma is suggested by the fact that 36 companies control the 63 plants that were in operation in this State at the end of 1915, compared with 35 companies and 58 plants at the end of 1914.

Gasoline from natural gas marketed in Oklahoma, 1914 and 1915.

1914.

County.	Plants.		Gasoline produced.		Average yield in gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
	Number in operation.	Daily capacity.	Quantity.	Value.		
		Gallons.	*Gallons.*		*Gallons.*	*° Baumé.*
Creek	30	44,353	[a]11,458,811	$712,930	1.5–6.8	66–92
Nowata	8	18,268	2,411,819	188,024	1.5–4.5	72–95
Tulsa	5	3,922	1,048,361	58,136	2.0–4.0	80–88
Muskogee	5	3,354	1,020,935	64,474	2.5–3.5	80–92
Okmulgee	5	2,900	742,079	46,580	1.0–2.8	76–92
Washington	4	1,996	595,550	42,915	0.6–2.5	70–90
Pawnee	1					
	58	74,793	17,277,555	1,113,059	3.01	.....

1915.

Creek	32	70,949	20,589,631	$1,496,177	0.5–3.0	70–96
Nowata	6	16,950	4,852,933	427,120	2.0–4.0	72–82
Tulsa	9	13,363	4,039,249	271,626	2.0–5.1	80–94
Okmulgee	6	4,275	855,992	68,707	1.0–2.5	76.87
Muskogee	6	4,036	704,188	56,199	2.5–4.5	85–94
Pawnee	1	1,890	623,998	41,200	0.6–2.0	70–92
Washington	3					
	63	111,463	31,665,991	2,361,029	3.60	.....

[a] Includes some gasoline produced in Tulsa County.

CALIFORNIA.

By increasing its output of casing-head gasoline from 7,581,309 gallons in 1914 to 12,835,126 gallons in 1915, a gain of 69 per cent, California advanced from third to second rank among the States in

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which this industry has been developed, exceeding its closest competitor, West Virginia, by a margin of approximately 2,000,000 gallons.

As the net gain in new plants in 1915 was only one plant, the increase in production is to be accounted for principally by the fact that the demand for gasoline in California was such as to warrant capacity operation at all plants and that 5 plants installed during 1914 were in operation the whole of 1915.

The rated capacity of the 20 casing-head gasoline plants in operation in California at the end of 1915 was 40,755 gallons a day, whereas the actual production computed on the basis of 300 working days was 42,783 gallons a day.

The value in 1915 of the unblended gasoline at the plants was $975,397, an average of 7.60 cents a gallon, compared with $633,517, an average of 8.36 cents a gallon in 1914.

On account of the low gasoline content of the natural gas produced in the oil fields of California, the quantity recovered represents the handling of a proportionately greater volume of gas than in any other State. The average recovery of gasoline per thousand cubic feet of California gas was 1.6 gallons in 1915, a gain of 0.12 gallon over the average in 1914. The volume of gas utilized in the manufacture of gasoline in 1915 is estimated at 8,006,888,000 cubic feet, or about 36 per cent of the total volume produced during the year. Its value at 3.6 cents a thousand, the average price paid for it by gasoline manufacturers, was $288,669.

The casing head gasoline industry in California is centered in the coastal and southern fields, though one plant was in operation in 1915 at Coalinga, Fresno County, and one at Taft, Kern County. In the latter district two plants were being installed at the end of the year. The Santa Maria district, Santa Barbara County, is the principal source of gasoline production, 7 plants in this district contributing 54 per cent of the output credited to the State in 1915. The following plants, having a daily capacity rated at 18,987 gallons and an average output, on the basis of 300 working days, of 23,107 gallons in 1915, were in operation in Santa Barbara County during the year: American Gas Co., 1 plant; Western Gasoline Co. (now T. R. Finley), 1 plant; Pinal Dome Oil Co., 2 plants; Purity Gasoline Co., 1 plant; Rice Ranch Oil Co., 1 plant; Union Oil Co. of California, 1 plant.

Second in importance as a contributor to the output of casing-head gasoline in California is Orange County, in which 5 plants, with a rated capacity of 11,736 gallons a day, produced 2,977,144 gallons of raw gasoline in 1915. The plants in Orange County include 2 at Brea—one owned by the Brea Gasoline Co. and the other by the Pacific Gasoline Co.; 1 at Oleo, owned by the Hurley, Smith & Collins Co.; 1 at Olinda, owned by the Olinda Gasoline Co.; and 1 at Stearns, owned by the Union Oil Co. of California.

In Los Angeles County the casing head gasoline industry is becoming increasingly important, being centered in the Salt Lake-Sherman district, a few miles west of Los Angeles. In this county plants were operated in 1915, as follows: In the Salt Lake-Sherman district, 4 plants—one each by the Columbia Oil Producing Co., the A. F. Gilmore Oil Co., the Hurley, Smith & Collins Co., and the Rancho La Brea Oil Co.; in the Coyote Hills, 1 plant operated by

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the Standard Oil Co. of California, in which the production of gasoline is incidental, the plant being a compressor station operated to supply gas to the company's refinery at El Segundo. At this latter plant the gasoline is mixed with crude oil and recovered eventually as straight-run gasoline at the refinery.

At Fillmore, Ventura County, the Montebello Oil Co. operates a plant that has a capacity in excess of 1,500 gallons of gasoline a day. The gasoline plant installed in 1914 in the Eastside field at Coalinga, Fresno County, by the Turner Oil Co. was operated in 1915 by the successors of that company, the Shell Co. of California.

Gasoline from natural gas marketed in California in 1914 and 1915.

1914.

County.	Plants.		Gasoline produced.		Average yield in gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
	Number in operation.	Daily capacity.	Quantity.	Value.		
		Gallons.	Gallons.		Gallons.	° Baumé.
Santa Barbara	8	16,378	4,225,384	$323,701	0.7 –2.0	75–80
Orange	4	10,602	2,403,050	222,334	1.0 –3.0	72–80
Los Angeles	4	1,889	576,104	59,453	0.75–3.0	62–80
Fresno	1					
Ventura	1	3,534	382,812	28,029	1.25–5.0	72–86
Kern	1					
	19	32,360	7,581,389	633,517	1.48	.....

1915.

Santa Barbara	7	18,987	6,932,284	$505,576	1.05–2.35	68–82
Orange	5	11,736	2,977,144	233,837	1.0 –2.5	67–75
Los Angeles	5	4,634	959,043	83,158	0.57–2.0	66–80
Kern	1					
Ventura	1	5,398	1,966,655	152,826	0.5 –2.0	69–80
Fresno	1					
	20	40,755	12,835,126	975,397	1.603	.....

WEST VIRGINIA.

Although the quantity of casing-head gasoline marketed from West Virginia plants in 1915 exceeded the quantity marketed in any previous year, this State was relegated to third rank by reason of the more rapid growth of the industry in California.

The quantity of raw gasoline marketed from the plants in West Virginia in 1915 was 10,853,608 gallons, and its value at the sources of production before blending was $927,079, a gain of 1,575,500 gallons, or 17 per cent, in quantity and of $235,180, or 34 per cent, in market value, compared with results in 1914. The larger gain in value than in quantity is accounted for by a steadily and rapidly advancing market for commercial gasoline during the closing months of 1915 that reacted on the market for casing-head gasoline, a product of immediate value for blending with low-grade naphthas and other refinery products to produce a commercial motor fuel.

A shortage of suitable gas in certain localities resulted in inactivity at a few plants and in the dismantling of one plant in Ritchie County

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and of two plants in Kanawha County. Several new plants were installed in West Virginia in 1915, and at the end of the year 114 plants with a combined capacity of 34,422 gallons of raw gasoline daily were in operation in the State, a net loss of 7 plants, but of only 38 gallons in rated daily capacity, compared with conditions at the end of 1914.

The casing head gasoline industry in West Virginia is distributed over 14 counties but is centered in Tyler County, where 46 plants, with a combined capacity of 14,047 gallons daily, contributed about 35 per cent of the product credited to West Virginia in 1915. Ritchie County was second, its 16 plants representing an aggregate daily capacity of 5,245 gallons, contributing 12 per cent of the production; and Kanawha County was third, its 7 active plants furnishing nearly 10 per cent of the output in 1915.

An appreciable percentage of the raw gasoline produced in West Virginia was made up of drips recovered at compressor stations of companies operating long-distance transmission lines.

The gasoline content of West Virginia gases utilized in the manufacture of gasoline ranges from a minimum of 0.3 gallon to the thousand cubic feet, reported by one plant in Kanawha County, to a maximum of 7 gallons, reported by one plant in Tyler County. The average for the State in 1915 was 2.3 gallons per thousand feet of gas used, exclusive of that involved in the production of drips.

Most of the residual gas from casing head gasoline plants in West Virginia is utilized. At only two or three plants was this gas reported as wholly wasted in 1915. At the majority of the plants such part of the residual gas as was not required in the operation of the plant was either used for drilling and pumping operations on adjacent properties, or was sold to gas distributing companies, domestic consumers, or carbon-black factories.

A significant outgrowth of the casing head gasoline industry that gives promise of increasing the utility of the natural-gas resources of West Virginia, as well as of the other gas-producing States of the country, is the manufacture of liquid natural gas, which was proved commercially feasible at an experimental plant at Elizabeth, Wirt County, in 1915. This product, which consists of ethane, propane, and the heavier and more readily liquifiable constituents of natural gas, is reported to possess advantages over its parent substance that greatly enlarge the scope of natural-gas application and render its benefits available to homes and industries outside the radius of practicable transportation of natural gas. Being free from methane, which remains gaseous under the conditions of temperature and pressure employed, its thermal value is from 50 to 150 per cent greater than that of natural gas and appreciably greater than that of acetylene, a condition which renders it applicable as a fuel in cutting and welding operations. Its compact form, its ready portability in specially designed steel bottles, its simplicity of application, and its relatively low cost of manufacture recommend it as a source of light and heat for railway cars and for country and suburban dwellings.

Thus far no use has been found for the ethane that forms 60 to 75 per cent of the volume of gas utilized at this plant, and it is allowed to waste.

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Gasoline from natural gas marketed in West Virginia, 1913–1915.

1913.

County.	Plants.		Gasoline produced.		Average yield in gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
	Number in operation.	Daily capacity.	Quantity.	Value.		
		Gallons.	*Gallons.*		*Gallons.*	° *Baumé.*
Tyler	47	13,011	3,228,641	$344,296	1.5–10.0	70 –97
Ritchie	15	6,710	1,440,531	146,804	1.0– 4.0	82 –96
Brooke	6	1,960	711,867	74,242	2.5– 3.0	85 –96
Wetzel	4	840	[a] 683,437	74,412	1.5– 2.0	60 –86
Pleasants	17	2,070	459,385	41,275	1.0– 4.0	80 –97
Hancock	5	1,825	301,125	37,471	2.0– 4.6	86 –92
Wood	9	660	198,232	21,089	1.5– 5.5	80 –105
Kanawha	4	2,564	144,699	15,908	2.0– 6.0	85.2–91.5
Calhoun	2	550				
Clay	1					
Wirt	1					
Marion	1	1,740	494,576	51,909	1.0– 3.0	80 –91
Marshall	1					
Harrison	1					
Doddridge	1					
	115	31,980	7,662,498	807,406	2.57	.....

1914.

Tyler	50	13,455	3,687,992	$238,337	1.0–4.0	75 –90
Ritchie	15	6,915	1,266,117	95,007	1.0–4.0	80 –90
Kanawha	6	5,464	673,757	46,167	0.1–5.0	75 –92
Brooke	7	2,181	599,426	49,014	2.0–5.0	85 –96
Pleasants	17	1,607	438,709	31,214	1.0–3.0	74 –96
Hancock	7	1,696	398,930	35,012	2.0–8.0	80 –90
Wetzel	5	800	194,866	14,562	1.5–2.0	83.2–86
Doddridge	3	725	172,084	13,452	2.0–2.5	83.2–96
Wood	6	517	110,729	7,164	2.0–3.0	80 –86
Calhoun	1					
Harrison	1					
Marion	1	1,100	[a] 1,735,498	111,970	2.0–3.0	83.2–87
Wirt	1					
Roane	1					
	121	34,460	9,278,108	691,899	2.58	.....

1915.

Tyler	46	14,047	3,784,573	$319,821	2.0–7.0	74–92
Ritchie	16	5,245	1,331,425	109,296	1.0–4.0	80–90
Kanawha	7	7,007	1,024,845	75,963	0.3–4.5	75–100
Brooke	9	2,325	603,419	55,568	2.0–6.0	84–92
Pleasants	13	1,615	426,961	33,677	2.0–3.0	80–90
Hancock	4	780	297,653	24,475	1.5–6.0	86–92
Wetzel	5	975	185,998	15,271	1.0–2.0	78–86
Doddridge	3	650	116,000	9,520	2.0–2.5	84–89
Wood	6	530	70,201	6,088	1.0–2.5	80–90
Clay	1					
Harrison	1					
Marion	1	1,248	[a] 3,012,533	277,400	0.3– 2.0	75–90
Roane	1					
Calhoun	1					
	114	34,422	10,853,608	927,079	2.3	.....

[a] Includes drips.

PENNSYLVANIA.

Although Pennsylvania is the birthplace of the casing head gasoline industry, it ranks only fourth among the States in which this industry has been developed.

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The quantity of gasoline produced from natural gas in Pennsylvania in 1915, which amounted to 5,898,597 gallons, was greater than the production in any preceding year and exceeded the output in 1914 by 1,286,859 gallons, or 28 per cent. Its value at the plants before blending, which amounted to $569,873, shows an even greater rate of increase compared with the value of the production in 1914, the gain being $201,471, or nearly 60 per cent, due to a greatly increased demand for this material for blending during the last half of 1915. The average price per gallon for raw gasoline at the plants increased from 7.79 cents in 1914 to 9.66 cents in 1915.

The casing head gasoline industry in Pennsylvania includes plants located in 12 counties, Armstrong and Clarion counties having been added to the list of gasoline-producing counties in 1915 and Elk County having been dropped. A net gain of 20 plants and of 1,298 gallons in daily capacity was made in 1915.

The principal sources of gasoline production in Pennsylvania in 1915 were Warren County with 35 active plants at the end of the year, McKean County with 13 active plants, and Butler County with 60 active plants. The combined output of gasoline from these three counties constitutes nearly 60 per cent of the total production credited to Pennsylvania in 1915, the remaining 40 per cent, including drips, being furnished by 31 plants distributed over 9 other counties.

The gasoline content of Pennsylvania gases utilized in the manufacture of gasoline ranges from a minimum of 0.5 gallon per thousand cubic feet of gas, reported by operators in Armstrong and Butler counties, to a maximum of 8.0 gallons per thousand, reported by one operator in Warren County. The average recovery for the State in 1915 was 2.73 gallons per thousand, a decrease of 0.16 gallon compared with the recovery attained in 1914.

The volume of natural gas utilized in the manufacture of gasoline in Pennsylvania in 1915 is estimated to have amounted to 1,838,034,000 cubic feet, valued at $186,325, a gain of 18 per cent in volume and of 48 per cent in value, compared with corresponding items in 1914.

Gasoline from natural gas marketed in Pennsylvania in 1913, 1914, and 1915.

1913.

County.	Plants.		Gasoline produced.		Average yield in gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
	Number in operation.	Daily capacity.	Quantity.	Value.		
		Gallons.	*Gallons.*		*Gallons.*	*°Baumé.*
Butler	52	4,995	944,009	$99,587	1.0-6.0	58-110
Warren	27	3,480	838,006	92,488	1.0-6.0	70- 96
McKean	10	7,298	573,466	69,179	2.0-4.5	86- 95
Allegheny	11	2,367	568,041	62,246	1.8-6.0	80- 90
Venango	5	1,345	265,982	24,293	1.0-4.0	70- 93
Forest	3	1,475	255,773	30,424	1.1-2.5	86- 90
Washington					6.0	87
Potter	5	1,256	234,819	26,969	1.25	84- 86
Greene					1.5	75
Crawford					1.0	80
	113	22,207	3,680,096	405,186	2.68	.....

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Gasoline from natural gas marketed in Pennsylvania in 1913, 1914, and 1915—Continued.

1914.

County.	Plants.		Gasoline produced.		Average yield in gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
	Number in operation.	Daily capacity.	Quantity.	Value.		
		Gallons.	*Gallons.*		*Gallons.*	*°Baumé.*
Warren	27	3,320	1,126,873	$57,355	1.0–7.0	74–94
Butler	54	4,359	1,022,481	74,772	1.0–8.0	74–98
McKean	9	7,010	985,975	78,175	2.0–5.0	86–95
Forest	6	2,380	583,229	52,058	2.0–2.5	86–90
Allegheny	13	2,192	529,634	39,135	1.8–6.0	74–92
Venango	3	800	132,645	10,227	2.0–4.0	70–90
Washington	7	1,395	230,901	17,589	5.0–6.0	85
Potter					1.5	86
Greene					2.0–5.0	74–90
Elk					2.0	78
Crawford					1.0	80
	119	21,456	4,611,738	359,402	2.89	.....

1915.

Warren	36	4,057	1,291,313	$115,635	1.0–8.0	66–100
McKean	13	8,450	1,204,980	135,974	1.5–4.3	68– 97
Butler	60	4,301	1,032,661	95,637	0.5–7.0	72– 95
Forest	4	2,100	543,778	55,275	2.0–4.0	85– 96
Allegheny	12	1,900	518,871	42,188	1.0–5.0	81– 88
Washington	4	500			3.0–5.0	80– 82
Venango	3	935			2.0–4.0	85– 95
Crawford					1.0–5.0	.....
Potter			[a] 1,307,894	125,164	1.5	.....
Greene	8	611			2.5	.....
Armstrong					0.5–4.0	70– 82
Clarion					1.0–3.0	71– 80
	139	22,754	5,898,597	568,873	2.73	.....

[a] Includes drips.

OHIO.

The output of natural-gas gasoline in Ohio in 1915, which amounted to 2,198,715 gallons, was a decline of 241,456 gallons, or nearly 10 per cent, compared with the output in 1914. Owing, however, to an increase of $0.06 in the average price of this output at the sources of production, the total value of the yield in 1915 was only 8 per cent less than that of the yield in 1914. Although there was a net gain of three in the number of gasoline plants in operation in Ohio at the end of 1915 compared with the number at the end of 1914, the volume of gas treated in 1915 was 8 per cent less than in 1914 and the average recovery of gasoline per thousand feet was less by 0.13 gallon than in 1914. In these factors lies a part of the explanation for the decrease in gasoline production in 1915. The remaining part of the explanation is believed to lie in conditions that are discussed in the section on Illinois.

Six counties contributed to the output of casing-head gasoline in Ohio in 1915, the plant formerly operated in Hancock County having been destroyed by fire and not rebuilt.

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More than 70 per cent of the production in 1915 came from 31 plants in Monroe County, where the yield of gas from individual wells is light, but where a maximum recovery of 6.6 gallons to the thousand cubic feet is possible. The remaining 30 per cent of the production was supplied by 5 plants in Jefferson County, 9 in Washington County, 2 in Columbiana County, 2 in Morgan County, and 1 in Fairfield County.

The maximum recovery of gasoline from natural gas in Ohio is 8 gallons to the thousand cubic feet reported by one operator in Jefferson County.

The average for the State in 1915 was 2.8 gallons per thousand feet.

The greater part of the residual gas from gasoline plants in Ohio is returned to the leases from which it is obtained for use in drilling and pumping operations.

Gasoline from natural gas marketed in Ohio, 1913, 1914, and 1915.

1913.

County.	Plants.		Gasoline produced.		Average yield in gasoline per thousand cubic feet of gas.	Average gravity of gasoline as produced and before blending.
	Number in operation.	Daily capacity.	Quantity.	Value.		
		Gallons.	*Gallons.*		*Gallons.*	*° Baumé.*
Monroe	24	5,187	1,469,490	$156,184	0.5 –5.0	84–97
Washington	10	1,380	298,748	29,444	1.25–3.0	80–92
Jefferson	2	600			4.0 –5.6	.....
Columbiana	2	250			3.0	92–95
Hancock	1		284,449	26,776		
Fairfield	1	775			2.0 –2.5	85–88
Morgan	1					
	41	8,142	2,072,687	212,404	2.79	.....

1914.

Monroe	31	6,115	1,645,821	$124,700	0.5–5.0	84–91
Jefferson	3	885	318,857	22,435	4.0–8.0	86–96
Washington	9	1,109	288,443	19,641	1.5–3.0	87–92
Columbiana					3.0	93
Hancock	4	1,210	187,050	17,321	2.5	85
Morgan					2.0	88
Fairfield					3.0	84–88
	47	9,319	2,440,171	184,097	2.86	.....

1915.

Monroe	31	5,920	1,562,387	$113,410	0.5–6.6	74–98
Jefferson	5	830	249,940	18,978	1.0–8.0	85–96
Washington	9	900	222,543	21,207	2.0–3.0	80–96
Columbiana	2					
Morgan	2	1,355	163,845	13,543	2.0–3.5	85–91
Fairfield	1					
	50	8,995	2,198,715	167,138	2.8	.....

ILLINOIS.

The number of plants producing gasoline from natural gas in Illinois increased from 14 in 1914 to 16 in 1915. The output of raw gasoline, however, decreased from 1,674,178 to 1,035,204 gallons, and the value of the production at the plants decreased from $100,331 to

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$80,049, with a decrease of 0.89 cent in average price per gallon. This retrogression is attributed to the situation of Illinois near the center of an area covering several States in which a trade war involving the control of markets for commercial gasoline in the Middle West was in progress during the greater part of 1915. As a consequence of this warfare, prices for raw casing-head gasoline at the plants declined to such a point as to deprive the operator of any substantial incentive to increase the output or the capacity of his plant. Although the warfare between the various marketing factions in this territory was mitigated before the end of 1915, the recovery of the gasoline market came too late in the year to reverse the decline in production of casing-head gasoline.

The industry in Illinois is restricted to the deep-sand, low-pressure fields of Crawford and Lawrence counties, where the gasoline content of the gas treated ranges from a minimum of 1 gallon to a maximum of 4 gallons to the thousand cubic feet, the average for the State in 1915 being 2.29 gallons.

TEXAS.

One plant for the extraction of gasoline from natural gas was installed and operated by the Corsicana Petroleum Co. in the Electra field, Wichita County, in 1915. At the end of the year an additional plant was being installed by the Producers Oil Co.

NEW YORK.

The casing head gasoline industry in New York is restricted to Allegany and Cattaraugus counties, where 4 plants, owned respectively by the Wirt Gasoline Co., the Power Gasoline Co., Curtis & Moore, and the Hydro Carbons Co. (Inc.), were operated in 1915. Two additional plants were idle during the year because of a scarcity of suitable gas.

The average recovery of gasoline from casing-head gas in the Allegany district is 2 gallons per thousand cubic feet and in the northern end of the Bradford district the range is between 2 gallons and 2.5 gallons per thousand.

LOUISIANA.

Two plants, owned, respectively, by the Standard Oil Co. of Louisiana and the Central Oil & Gasoline Co., for the extraction of gasoline from natural gas were installed and operated in Louisiana in 1915. Both are in Caddo Parish and utilize gas from the Caddo district, from which the recovery of gasoline ranges between a minimum of 1 gallon and a maximum of 3 gallons to the thousand cubic feet.

KANSAS.

The casing head gasoline industry in Kansas was restricted in 1915 to Chautauqua County, where 3 plants were operated. One plant, that of the Riverside Western Oil Co., at Peru, was operated during only a part of 1915, being dismantled in September because of the exhaustion of the available gas supply. The other two, owned respectively by the Sedan Gasoline Co. and the Vulcan Oil & Gas Co., operated the entire year.

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The gasoline content of the natural gas used at the Kansas plants in 1915 is reported to range from a minimum of 0.5 gallon to 2 gallons to the thousand cubic feet.

COLORADO.

Two plants, owned respectively by the Boulder-Greely Oil Co. and the Inland Oil & Refining Co., for the extraction of gasoline from natural gas were in operation in Colorado in 1915. Both are located at Boulder and both derive their supply of gas from the low-pressure wells in the old Boulder field. Although the volume of gas available in this field is small, it is highly suitable for the manufacture of gasoline, the recovery per thousand cubic feet ranging between 4 and 5 gallons.

KENTUCKY.

For several years Kentucky has contributed to the annual production of natural-gas gasoline in the United States, its contributions prior to 1915 consisting wholly of drips resulting from the normal condensation of vapors in natural-gas mains. In 1915 the contribution was increased several hundred per cent by the output of a gasoline plant installed by the Wood Oil Co., near Monticello, Wayne County. Late in 1915 an additional plant was installed by the New Domain Oil & Gas Co., though it was not put in operation until February, 1916.

CITIES AND TOWNS SUPPLIED WITH NATURAL GAS.

The following list contains the names of cities and towns in the United States which were either wholly or in part supplied with natural gas in the year 1915:

ALABAMA.

Fayette.
Jasper.

ARKANSAS.

Argenta.
Arkadelphia.
Bauxite.
Benton.
Bierne.
Boughton.
Bryant.
Donaldson.
Emmet.
Fort Smith.
Garland.
Gifford.
Gum Springs.
Gurdon.
Hope.
Hot Springs.
Huntington.
Little Rock.
Mabelvale.
Malvern.
Mansfield.
Perla.
Pine Bluff.
Prescott.
Pulaska Heights.
Ravana.
Sheridan.
Texarkana.
Van Buren.

CALIFORNIA.

Alhambra.
Anaheim.
Athens.
Arroyo Grande.
Bakersfield.
Betteravia.
Burbank.
Cement.
Compton.
Cudahy.
Eagle Rock.
Fairfield.
Fellows.
Fullerton.
Gardena.
Garden Grove.
Glendale.
Guadaloupe.
Huntington Park.
Lodi.
Long Beach.
Los Angeles.
Los Berros.
Lynwood.
Maricopa.
Moneta.
Nipomo.
Orange.
Orcutt.
Oxnard.
Pasadena.
Placentia.
Redondo Beach.
Sacramento.
San Fernando.
San Gabriel.
Santa Ana.
Santa Maria.
Santa Monica.
Santa Paula.
Sawtelle.
South Pasadena.
South Taft.
Stockton.
Suisun City.
Summerland.
Taft.
Torrance.
Tustin.
Tropico.
Venice.
Ventura.
Vernon.

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ILLINOIS.

Annapolis.
Birds.
Bridgeport.
Carlinville.
Casey.
Duncanville.
East Chicago.
Eaton.
Flat Rock.
Greenville.
Heyworth.
Hutsonville.
Lawrenceville.
Marshall.
Martinsville.
New Hebron.
Oblong.
Olney.
Palestine.
Pinkstaff.
Porterville.
Robinson.
Stoy.
Sumner.

INDIANA.

Adams.
Albany.
Alexandria.
Anderson.
Arcadia.
Atlanta.
Batesville.
Blue Ridge.
Cambridge.
Carmel.
Carthage.
Charlottesville.
Chesterfield.
Cicero.
Clarkesburg.
Connersville.
Converse.
Cowan.
Daleville.
Downeyville.
Dublin.
Dunkirk.
Dunreith.
Eaton.
Elwood.
Fairmount.
Falmouth.
Farmland.
Fortville.
Fountaintown.
Frankton.
Freeport.
Geneva.
Gentryville.
Germantown.
Gowdy.
Greenfield.
Greensburg.
Gwynneville.
Hagerstown.
Hartford City.
Herbst.
Homer.
Honey Creek.
Hope.
Hortonville.
Kennard.
Knightstown.
Kokomo.
La Fontaine.
Letts.
Lewisville.
Loogootee.
Lynn.
McCordsville.
Manilla.
Marion.
Markleville.
Maxwell.
Mays.
Middletown.
Mier.
Milford.
Millgrove.
Millhousen.
Milroy.
Milton.
Modoc.
Mohawk.
Montpelier.
Morristown.
Mount Auburn.
Mount Summit.
Muncie.
Newcastle.
New Lisbon.
New Point.
Noblesville.
Normal City.
Oklandon.
Oakland City.
Oakville.
Ovid.
Pendleton.
Pennville.
Portland.
Powers.
Princeton.
Raleigh.
Raysville.
Redkey.
Richmond.
Ridgeville.
Riverside.
Rushville.
St. Paul.
Sandusky.
Sardinia.
Sharpsville.
Shelbyville.
Sheridan.
Shirley.
Spiceland.
Springport.
Straughn.
Sullivan.
Sweetsers.
Tipton.
Union City.
Vincennes.
Waldron.
Warrington.
West Liberty.
Westport.
Williamstown.
Winchester.
Windfall.
Winslow.

KANSAS.

Altamont.
Altoona.
Arkansas City.
Atchison.
Atlanta.
Augusta.
Baldwin City.
Bartlett.
Bassett.
Baxter Springs.
Belle Plaine.
Benedict.
Bentley.
Bonner Springs.
Bronson.
Buffalo.
Buffville.
Burden.
Burlington.
Burrton.
Cambridge,
Caney,
Carlyle.
Chanute.
Chautauqua Springs
Cherokee.
Cherryvale.
Chetopa.
Coffeyville.
Colony.
Columbus.
Cottonwood Falls.
Coyville.
Deerfield.
Derby.
Douglass.
Earleton.
Edgerton.
Edna.
Edwardsville.
Eldorado.
Elk City.
Elk Falls,
Elm.
Elmdale.
Elsmore.
Empire City.
Emporia.
Erie.
Eudora.
Eureka.
Fairhaven.
Fall River.
Fort Scott.
Fredonia.
Galena.
Gardner.
Garnett.
Gas.
Greeley.
Grenola.
Hackney.
Halstead.
Havana.
Haven.
Hepler.
Howard.
Humboldt.
Hunnewell.
Hutchinson.
Independence.
Iola.
Jefferson.
Kansas City.
Labette.
La Harpe.
Lawrence.
Leavenworth.
Lenexa.
Liberty.
Merriam.
Moline.
Moran.
Mound City.
Mound Valley.
Mount Hope.
Mulvane.
Neodesha.

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New Albany.
New Salem.
Newton.
Niotaze.
North Altoona.
Olathe.
Osawatomie.
Oswego.
Ottawa.
Oxford.
Paola.
Parsons.
Peru.
Pittsburg.
Pleasanton.
Princeton.
Rantoul.
Richmond.
Roper.
Rose.
Savonburg.
Scammon.
Scipio.
Sedan.
Sedgwick.
Shawnee.
Spring Hill.
Stanley.
Strong.
Sycamore.
Thayer.
Tonganoxie.
Topeka.
Turner.
Tyro.
Udall.
Valley Center.
Vilas.
Weir.
Welda.
Wellington.
Wellsville.
Wichita.
Winfield.
Yates Center.

KENTUCKY.

Ashland.
Barbourville.
Bellevue.
Buchanan.
Burning Springs.
Caney.
Cannel City.
Catlettsburg.
Central City.
Chinnville.
Clifton.
Clintonville.
Cloverport.
Cold Spring.
Covington.
Dayton.
Diamond.
Dover.
Foster.
Greenup.
Hazel Green.
Ines.
Kenner.
Kavanaugh.
Lexington.
Louisa.
Louisville.
Ludlow.
Maysville.
Mount Sterling.
Newport.
North Middletown.
Paintsville.
Paris.
Pollard.
Rothwell.
Russell.
Salyersville.
Warfield.
Wayland.
West Covington.
West Liberty.
West Point.
Winchester.
Worthington.

LOUISIANA.

Belcher.
Blanchard.
Bossier.
Cedar Grove.
Dixie.
Hosston.
Ida.
Lewis.
Mansfield.
Mooringsport.
Mystic.
Naborton.
Oil City
Rodessa.
Shreveport.
Vivian.

MARYLAND.

Barton.
Cumberland.
Deer Park.
Frostburg.
Kitzmillerville.
Klondike.
Loch Lynn.
Lonaconing.
Luke.
Midland.
Mountain Lake Park
Mount Savage.
Oakland.
Western Port.

MISSOURI.

Carl Junction.
Carterville.
Carthage.
Deerfield.
Duenweg.
Joplin.
Kansas City.
Martin City.
Nevada.
Oronogo.
Parkville.
Prosperity.
St. Joseph.
Webb City.
Weston.

NEW YORK.

Addison.
Akron.
Alden.
Alexander.
Alfred.
Alfred Station.
Allentown.
Almond.
Ambush.
Amherst.
Andover.
Angelica.
Angola.
Armor.
Attica.
Avon.
Baldwinsville.
Batavia.
Belfast.
Belmont.
Bergen.
Blasdell.
Blossom.
Bolivar.
Bowmansville.
Brant.
Bristol.
Bristol Center.
Brocton.
Buffalo.
Caledonia.
Canisteo.
Cattaraugus.
Ceres.
Chautauqua.
Chipmonk.
Churchville.
Clarence.
Clarence Center.
Collins.
Collins Center.
Corfu.
Corning.
Crittenden.
Cuba.
Deer Creek.
Depew.
Dunkirk.
East Aurora.
East Bloomfield.
East Hamburg.
East Pembroke.
Ebenezer.
Eden.
Ellicott.
Elma.
Elmira.
Evans.
Falconer.
Farnham.
Forestville.
Fredonia.
Friendship.
Gangloff.

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Gardenville.
Genesee.
Getzville.
Gorham.
Gowanda.
Greenwood.
Hamburg.
Hanover.
Holcomb.
Holland.
Honeoye Falls.
Hornell.
Independence.
Irving.
Jamestown.
Jamieson Road.
Jewettville.
Lacona.
Lackawanna.
Lancaster.
Le Roy.
Lima.
Limestone.
Linwood.
Little Valley.
Millgrove.
Montour Falls.
Moscow.
Mount Morris.
Mumford.
Naples.
North Buffalo.
North Collins.
North Tonawanda.
Obi.
Olean.
Orchard Park.
Otto.
Pavilion.
Perry.
Petrolia.
Phoenix.
Pomfret.
Portland.
Portville.
Pulaski.
Reserve.
Rexville.
Richburg.
Riga.
Ripley.
Rushville.
Salamanca.
Sandy Creek.
Scio.
Sheridan.
Silver Creek.
Southport.
Springville.
Stafford.
Stanards.
Stockton.
Tonawanda.
Town Line.
Versailles.
Warsaw.
Watkins.
Webb Mills.
Wellsville.
West Bloomfield.
West Clarksville.
Westfield.
West Phoenix.
West Seneca.
Wheatland.
Williamsville.
Wyoming.
York.
Zoar.

NORTH DAKOTA.

Lansford.

OHIO.

Academia.
Ada.
Adelphi.
Akron.
Alexandria.
Alger.
Alliance.
Amanda.
Amboy.
Amesville.
Amherst.
Amsterdam.
Andover.
Antioch.
Appleton.
Arcanum.
Arlington.
Ashland.
Ashtabula.
Ashville.
Athens.
Austinburg.
Avery.
Bairdstown.
Baltimore.
Bangs.
Barberton.
Barlow.
Barnesville.
Bartlett.
Basil.
Batesville.
Beach City.
Beallsville.
Beem City.
Bellaire.
Belle Valley.
Belleville.
Bellevue.
Belmont.
Beloit.
Belpre.
Berea.
Bergholz.
Berlin Heights.
Bethany.
Bethesda.
Bettsville.
Beverly.
Bexley.
Birmingham.
Bladensburg.
Bloomdale.
Bloomingburg.
Bloomington.
Bowerston.
Bowling Green.
Bradrick.
Brandon.
Bratenahl.
Bremen.
Bridgeport.
Brilliant.
Brink Haven (Gann).
Brookfield.
Brook Park.
Brookville.
Buckeye City.
Buckeye Lake.
Buchtel.
Buckingham.
Bucyrus.
Buffalo.
Bullett Park.
Burbank.
Burgoon.
Butler.
Byesville.
Cadiz.
Caldwell.
Cambridge.
Canaanville.
Canal Dover.
Canal Winchester.
Canfield.
Canton.
Cardington.
Carey.
Carroll.
Carrollton.
Castine.
Cedarville.
Celina.
Centerburg.
Chatham.
Chauncey.
Chesapeake.
Chesterhill.
Chicago Junction.
Chillicothe.
Chippewa Lake.
Cincinnati.
Circleville.
Clarington.
Claysville.
Clearport.
Cleveland.
Cleveland Heights.
Clintonville.
Clyde.
Coal Grove.
Coal Run.
Coalton.
Cochransville.
Coldwater.
Columbiana.
Columbus.
Conneaut.
Corning.
Corryville.
Coshocton.
Covington.
Crestline.
Creston.
Cridersville.
Crooksville.
Croton.
Cuyahoga Falls.
Cygnet.
Dakes.
Danville.
Dayton.
Deavertown.
Delaware.
Dennison.
Derwent.
Dexter City.
Dover.
Doylestown.
Drakes.
Dresden.
Dudley.
East Cleveland.
East Fultonham.
East Liverpool.
East Palestine.
East Richmond.
East View.
East Youngstown.
Eaton.
Edison.
Elba.
Eldorado.
Elmore.
Elyria.
Empire.
Enterprise.
Etna.
Euclid.
Euphemia.
Fairfield.
Fairview.
Findlay.
Florence.
Flushing.
Fly.
Forest.
Fort Recovery.

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Fostoria.
Franklin.
Frazeysburg.
Fredericktown.
Fremont.
French Creek (Avon)
Fulda.
Fultonham.
Gahanna.
Galena.
Galion.
Gallipolis.
Gambier.
Geneva.
Genoa.
Germantown.
Gibsonburg.
Girard.
Glenroy.
Glouster.
Gore.
Grandview.
Granville.
Graysville.
Greenville.
Grogan.
Groveport.
Guysville.
Hallsville.
Hamden.
Hamilton.
Hanging Rock.
Hannibal.
Hanover.
Hanoverton.
Harlem Springs.
Harpster.
Harriettsville.
Haydenville.
Hayesville.
Hebron.
Helena.
Hemlock.
Homer.
Homeworth.
Hooker.
Hopedale.
Horns Mills.
Howard.
Hubbard.
Huntsville.
Irondale.
Ironton.
Jackson.
Jackson Center.
Jacksontown.
Jacksonville.
Jefferson.
Jeromesville.
Jerusalem.
Jewett.
Johnstown.
Jolly.
Junction City.
Kansas.
Kenmore.
Kent.
Kenton.
Kilgore.
Kilbuck.
Kingston.
Kingsville.
Kirkersville.
Lakeside.
Lakeview.
Lakewood.
Lancaster.
Laurelville.
Leesville.
Leetonia.
Leonard.
Leroy.
Lewisburg.
Lewisville.
Lexington.
Lima.
Linden.
Lisbon.
Litchfield.
Lock.
Lockville.
Lodi.
Logan.
London.
Lorain.
Lottasburg.
Loudonville.
Lowell.
Lowellville.
Lower Salem.
Ludington.
McArthur.
McConnelsville.
Macksburg.
Malaga.
Malta.
Mansfield.
Maple Heights.
Maria Stein.
Marietta.
Marion.
Martinsburg.
Martins Ferry.
Massillon.
Maumee.
Medina.
Mendon.
Miamisburg.
Middleport.
Middletown.
Mifflin.
Milan.
Millersburg.
Millersport.
Millers Run.
Millertown.
Millwood.
Milo.
Miltonsburg.
Mineral City.
Mingo.
Minster.
Monroe.
Monroeville.
Montezuma.
Morral.
Morristown.
Mount Gilead.
Mount Liberty.
Mount Sterling.
Mount Vernon.
Mount Victory.
Moxahala.
Murray City.
Nashport.
Negley.
Nelsonville.
Neptune.
Nevada.
New Albany.
New Alexandria.
Newark.
New Athens.
New Berlin.
New Boston.
New Bremen.
Newburgh.
Newburgh Heights.
New Carlisle.
New Castle.
Newcomerstown.
New Hagerstown.
New Knoxville.
New Lexington.
New Matamoras.
New Madison.
New Middletown.
New Paris.
New Philadelphia.
Newport.
New Riegel.
New Springfield.
New Straitsville.
Niles.
North Amherst.
North Baltimore.
North Georgetown.
North Hampton.
North Kingsville.
North Lima.
North Olmsted.
Norwalk.
Norwood.
Nottingham.
Oakfield.
Oakharbor.
Oberlin.
Orrville.
Osborn.
Osgood.
Outville.
Ozark.
Pataskala.
Pennsville.
Perrysburg.
Perrysville.
Petersburg.
Pickerington.
Piqua.
Pleasant City.
Pleasantville.
Plymouth.
Point Pleasant.
Poland.
Polk.
Pomeroy.
Portage.
Portsmouth.
Proctorville.
Quaker City.
Ravenna.
Red Haw.
Reedurban.
Rendville.
Reno.
Rex Mills.
Reynoldsburg.
Richmond.
Rittman.
Rockbridge.
Rock Creek.
Rockyridge.
Rocky River.
Roseville.
Roxbury.
Rowsburg.
Rural.
Rushville.
Rutland.
St. Clairsville.
St. Henry.
St. Louisville.
St. Marys.
Salem.
Salineville.
Saltpetre.
Sandusky.
Sarahsville.
Sardis.
Scio.
Sciotoville.
Sebring.
Senacaville.
Seville.
Shadyside.
Shaker Heights.
Sharon.
Sharonville.
Shawnee.
Shelby.
Shepard.
Sherodsville.
Shreve.
Sidney.
Simons.
Somerset.
Somerton.
South Charleston.
South Newburgh.
South Olive.
South Pleasantville.
South Zanesville.
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Spencerville.
Springfield.
Stafford.
Sterling.
Steubenville.
Stewart.
Stockport.
Stoutsville.
Strasburg.

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Texas.
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Thurston.
Tiffin.
Tippecanoe City.
Tiro.
Toledo.
Toronto.
Tremont City.
Trimble.
Trinway.
Troy.
Uhrichsville.
Union City.
Union Station.
Upper Sandusky.
Urbana.
Utica.
Vanburen.
Vanlue.
Vincent.
Wadsworth.
Wapakoneta.
Warner.
Warren.
Warsaw.
Washington Court House.
Washingtonville.
Waterford.
Waterloo.
Watertown.
Waterville.
Wellington.
Wellston.
Wellsville.
West Alexandria.
West Bedford.
West Carrollton.
Westerville.
West Jefferson.
West Lafayette.
West Manchester.
West Millgrove.
West Park.
West Rushville.
West Salem.
Wheelersburg.
Whipple.
White Cottage.
Wilberforce.
Williamsport.
Woodsfield.
Wooster.
Worthington.
Yellow Springs.
Youngstown.
Xenia.
Zanesville.
Zenz City.

OKLAHOMA.

Ada.
Arcadia.
Ardmore.
Avant.
Bartlesville.
Bartlett.
Beggs.
Bigheart.
Bixby.
Blackwell.
Bluejacket.
Boynton.
Braman.
Bristow.
Broken Arrow.
Cameron.
Cathay.
Chandler.
Checotah.
Chelsea.
Choteau.
Claremore.
Cleveland.
Coalton.
Collinsville.
Commerce.
Copan.
Coweta.
Cross.
Cushing.
Davenport.
Dawson.
Delaware.
Depew.
Dewar.
Dewey.
Drumright.
Duncan.
Dustin.
Edmond.
Eufaula.
Garnett.
Gotebo.
Guthrie.
Hallett.
Haskell.
Hattonville.
Henryetta.
Hominy.
Inola.
Jenks.
Jennings.
Kellyville.
Kiefer.
Kildare.
Lawton.
Lenapah.
Locust Grove.
Luther.
Marlow.
Meeker.
Miami.
Midlothian.
Morris.
Mounds.
Muskogee.
Newkirk.
Nowata.
Ochelata.
Oglesby.
Oilton.
Okewah.
Oklahoma.
Okmulgee.
Oologah.
Osage.
Owasso.
Pawhuska.
Ponca.
Porter.
Poteau.
Pryor.
Ramona.
Red Fork.
Red Oak.
Sand-Springs.
Sapulpa.
Schulter.
Shawnee.
Skiatook.
South Coffeyville.
Spiro.
Stidham.
Stroud.
Terlton.
Tonkawa.
Tulsa.
Turley.
Vinita.
Wagoner.
Wainwright.
Wann.
Welch.
Wellston.
Whiteagle.
Wirt.
Yale.

PENNSYLVANIA.

Adamsburg.
Aliquippa.
Altoona.
Alverton.
Alum Rock.
Ambridge.
Apollo.
Ardmore.
Argentine.
Arnold.
Austin.
Avalon.
Avonmore.
Axelton.
Baden.
Baldwin.
Barnes.
Beallsville.
Beaver.
Beaver Falls.
Belle Vernon.
Bellevue.
Bentleyville.
Betula.
Bingham.
Blackstown.
Blacksville.
Blairs Corners.
Blairsville.
Bloomster.
Bluff.
Bolivar.
Boston.
Bowerton.
Boyers.
Bradford.
Bradys Bend.
Branchton.
Brockport.
Brockwayville.
Brookston.
Brookville.
Brownsville.
Bruceton.
Bruin.
Bryant.
Buena Vista.
Buffalo.
Bullion.
Bully Hill.
Burdette.
Burgettstown.
Burnsville.
Burtville.
Butler.
Cabot.
Caledonia.
California.
Callensburg.
Callery.
Campbelltown.
Candor.
Canonsburg.
Carbon Center.
Carnegie.
Carnot.
Carrick.
Carrolltown.
Castle Shannon.
Cecil.
Centerville.
Ceres.
Charleroi.
Chicora.
Church.
Clairton.

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Clarendon.
Clarendon Boro.
Clarington.
Clarion.
Clarksburg.
Claysville.
Clermont.
Clintonville.
Cochranton.
Colegrove.
Coleville.
Colona.
Connellsville.
Conoquenessing.
Conway.
Cooksburg.
Cooperstown.
Coraopolis.
Corry.
Corsica.
Coryville.
Costello.
Coudersport.
Courtney.
Cowanesque.
Craigsville.
Cresson.
Crosby.
Curllsville.
Dahoga.
Darlington.
Davistown.
Dawson.
Dayton.
Deemston.
Delmont.
Dempseytown.
Derrick City.
Derry.
Donora.
Dubois.
Duke Center.
Dunbar.
Dunkard.
East Brady.
East Hickory.
East McKeesport.
Easton.
East Sharon.
East Springfield.
East Titusville.
Edgewood.
Edgeworth.
Edinburg.
Eidenau.
Elbon.
Eldersville.
Eldora.
Eldred.
Elizabeth.
Elkland.
Ellwood City.
Emlenton.
Emporium.
Emsworth.
Endeavor.
Enon Valley.
Enterprise.
Erie.
Evans City.
Export.
Fairhope.
Fairmount City.
Fairhaven.
Fairview.
Falls Creek.
Farrell.
Fayette City.
Finleyville.
Fisher.
Florence.
Ford City.
Fosters Mills.
Foxburg.
Franklin.
Fredonia.
Freedom.
Freeport.
Frogtown.
Fryburg.
Gaines.
Galeton.
Garards Fort.
Garland.
Gastonville.
Genesee.
Geneva Hill.
Gibsonton.
Gill Hall.
Gilmore.
Ginger Hill.
Girard.
Glade Run.
Glassport.
Glendale.
Glenfield.
Glenhazel.
Glen Osborne.
Glenwillard.
Grand Valley.
Graysville.
Great Belt.
Greenfield.
Greenock.
Greensboro.
Greensburg.
Greenville.
Gresham.
Grove City.
Guitonville.
Hackett.
Hadley.
Haffey (Milltown).
Halsey.
Harmony.
Harpers Corners.
Harrison City.
Harrison Valley.
Harrisville.
Hawthorn.
Haysville.
Hazel Hurst.
Heidelburg.
Hendersonville.
Henrys Bend.
Herman.
Hickory.
Highland.
Hilliards.
Hillsville.
Holbrook.
Hollidaysburg.
Homer.
Homer City.
Hooker.
Hopwood.
Houston.
Hydetown.
Imperial.
Indiana.
Industry.
Ingomar.
Instanter.
Irvineton.
Irwin.
Jackson Center.
Jacksonville.
James City.
Jamestown.
Jeannette.
Jefferson.
Johnetta.
Johnsonburg.
Johnstown.
Jollytown.
Juniata.
Kane.
Kane Boro.
Kane City.
Karns City.
Kaylor.
Keisters.
Kelletsville.
Khedive.
Kingsville.
Kinzua.
Kittanning.
Knox.
Knoxville.
Kushequa.
Lamartine.
Lamont.
Langloth.
Larabee.
Larimer.
Latrobe.
Lawrenceville.
Leechburg.
Leeper.
Leesburg.
Leetsdale.
Lewis Run.
Lickingville.
Ligonier.
Limestone.
Livermore.
Logans Ferry.
Loretta.
Lucinda.
Ludlow.
McClellandtown.
McDonald.
McKees Rocks.
McKinley.
Manor.
Manorville.
Mapletown.
Marble.
Marianna.
Marienville.
Mars.
Marvindale.
Marwood.
Masontown.
Matildaville.
Mayburg.
Mayport.
Meadow Lands.
Meadville.
Mechanicsville.
Mercer.
Middle Fork.
Midland.
Millers Eddy.
Millport.
Monaca.
Monaca Heights.
Monessen.
Monongahela.
Monroeville.
Monterey.
Mount Alton.
Mount Jewett.
Mount Morris.
Mount Oliver.
Mount Pleasant.
Murrysville.
Myonia.
Natrona.
Nedskey.
Nelson.
New Bethlehem.
New Brighton.
New Castle.
New Eagle.
New Florence.
New Freeport.
New Galilee.
New Kensington.
New Mayville.
New Salem.
New Sheffield.
New Stanton.
Newton.
Newtown Mills.
New Wilmington.
Noblestown.
North Bessemer.
North Blackville.
North East.
North Girard.
North Irwin.
North Warren.
Norwich.
Oakdale.
Oakland.
Oak Ridge.
Oil City.
Ormsby.
Osceola.
Osgood.
Oswayo.

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Otto.
Parker.
Parkers Landing.
Petersville.
Petroleum Center.
Petrolia.
Philipston.
Pittsburgh.
Pittsfield.
Pleasantville.
Plummer.
Point Marion.
Polk.
Pollock.
Portage.
Port Allegany.
Port Barnett.
Porter.
Portersville.
Portland Mills.
Poseytown.
Potter Brook.
Primrose.
Prospect.
Punxsutawney.
Queen.
Queenstown.
Rankin.
Ratigan.
Raymilton.
Red Fork.
Redman.
Red Rock.
Reidsburg.
Renfrew.
Reno.
Reynoldsville.
Richmond.
Ridgway.
Rimer.
Rimer Hill.
Rimersburg.
Rixford.
Rochester.
Rockland.
Rockmere.
Rogersville.
Rolfe.
Roscoe.
Roseville.
Roulette.
Rouseville.
Rural Valley.
Russell.
Rynd Farm.
St. Marys.
St. Petersburg.
Sabinsville.
Salem.
Salina, Venango County.
Salina, Westmoreland County.
Saltsburg.
Sandy Lake.
Sankertown.
Saxonburg.
Scottdale.
Semples.
Seneca.
Sewickley.
Sharon.
Sharon Center.
Sharpsville.
Shawmut.
Sheffield.
Shinglehouse.
Shinglehouse Boro.
Shippenville.
Sligo.
Slippery Rock.
Smethport.
Smiths Ferry.
Snowden.
South Brownsville.
South Heights.
South Jeannette.
South Sharon.
Spring Church.
Stoneboro.
Stoneham.
Straight.
Strattonville.
Sturgeon.
Sugar Creek.
Summerville.
Summit.
S. W. Greensburg.
Swissvale.
Tarentum.
Tarrs.
Taylorstown.
Tidal.
Tidioute.
Tiona.
Tionesta.
Titusville.
Townville.
Troutman.
Turtle Creek.
Tylersburg.
Ulysses.
Uniontown.
Unity.
Upper Middletown.
Utica.
Valley Station.
Van.
Vanderbilt.
Vandergrift.
Vanport.
Venetia.
Venus.
Verona.
Video.
Volant.
Walkers Mills.
Waltersburg.
Warren.
Warren Boro.
Washington.
Waters.
Waynesburg.
Webster.
West Alexander.
West Branch.
West Elizabeth.
West End Boro.
Westfield.
West Freedom.
West Hickory.
Westline.
West Middlesex.
West Middletown.
West Monongahela.
West Monterey.
Westmoreland City.
West Newton.
West Sunbury.
West Winfield.
Wetmore.
Wheatland.
Whiskerville.
Whitetown.
Wick.
Widnoon.
Wilcox.
Wilkinsburg.
Wilson.
Wireton.
Woodlawn.
Worthington.
Youngsville.
Youngwood.
Zelienople.

SOUTH DAKOTA.

Fort Pierre.
Pierre.

TEXAS.

Abilene.
Albany.
Alvord.
Arlington.
Atlanta.
Baird.
Bangs.
Bellevue.
Bloomburg.
Bowie.
Bridgeport.
Byers.
Cass.
Cisco.
Clyde.
Corsicana.
Crowther.
Dallas.
Dalworth.
Decatur.
Denison.
Denton.
Eagle Ford.
Electra.
Fort Worth.
Gainesville.
Grand Prairie.
Groesbeck.
Henrietta.
Highland Park.
Irving.
Kirk.
Laredo.
Leigh.
Marshall.
Mart.
Mexia.
Moran.
Niles.
Petrolia.
Polytechnic.
Putnam.
Queen City.
Rhome.
Richland.
Santa Anna.
Sherman.
Sunset.
Teague.
Tehuacana.
Texarkana.
Trinity Heights.
Waco.
Whitesboro.
Wichita Falls.
Wortham.

WEST VIRGINIA.

Adamston.
Adrian.
Alma.
Alvord.
Amma.
Arvilla.
Auburn.
Bannister.
Barboursville.
Barrackville.
Bayard.
Belington.
Belmont.
Bens Run.
Benwood.
Benson.
Beraman.
Berea.
Bigbend.
Big Creek.

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Big Isaac.
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Blacksville.
Blaine.
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Blueville.
Boothsville.
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Bridgeport.
Briscoe.
Bristol.
Broad Oaks.
Brookville.
Buckhannon.
Buffalo.
Burning Springs.
Burnsville.
Burton.
Cairo.
Cameron.
Cannelton.
Cedargrove.
Center Point.
Centerville.
Ceredo.
Charleston.
Chelyan.
Chester.
Clarington.
Clarksburg.
Clendenin.
Coalburg.
Coburns Creek.
Coger.
Colfax.
Colliers.
Columbia Mines.
Corinth.
Crawford.
Creston.
Crown Hill
Culloden.
Danville.
Davis.
Davissons Run.
Daybrook.
Deanville.
Dobbin.
Dunbar.
Eastbank.
East Lynn.
Edgewood.
Elizabeth.
Elkins.
Elk Garden.
Elk View.
Ellenboro.
Elm Grove.
Elm Run.
Enterprise.
Erie.
Eureka.
Fairmont.
Fairview.
Farmington.
Farnum.
Finch.
Fink.
Flat Woods.
Flemington.
Follansbee.
Fort Gay.
French Creek.
Frenchton.
Friendly.
Fulton.
Gandeeville.
Gassaway.
Gaston.
Gay.
Glen Dale.
Glen Easton.
Glen Falls.
Glenova.
Glenwood.
Glenville.
Glovergap.
Goose Creek.
Gormania.
Gould.
Grafton.
Grantsville.
Grasselli.
Griffithsville.
Hamlin.
Handley.
Hannahda'
Hansford.
Harrisville.
Haymond Heights.
Haywood.
Heaters.
Henry.
Hepzibah.
Horner.
Hundred.
Huntington.
Hurricane.
Hutchinson.
Industrial.
Ireland.
Jacksonburg.
Janelew.
Jarvisville.
Johnstown.
Jordan Creek.
Kelly Hill.
Kempton.
Kenova.
Kermit.
Keyser.
Kygar.
Lima.
Littleton.
Logan.
Longacre.
Lost Creek.
Loudenville.
Loveland.
Lumberport.
McMechen.
Madison.
Mahone.
Mannington.
Martha.
Meadowbrook.
Metz.
Middlebourne.
Miletus.
Milton.
Monongah.
Montgomery.
Montpelier.
Monticello Add.
Morgantown.
Moundsville.
Mount Clare.
Mount Zion.
Murphytown.
Myra.
Newark.
New Cumberland.
New Martinsville.
North View.
Norwood Park.
Ogdin.
Ona.
Orlando.
Paden City.
Palestine.
Parkersburg.
Parsons.
Patterson.
Peel Tree.
Pennsboro.
Peoria.
Perry Mines.
Petroleum.
Peytona.
Philippi.
Piedmont.
Pine Grove.
Pleasant Valley.
Poca.
Point Comfort.
Point Pleasant.
Pratt.
Proctor.
Pruntytown.
Pullman.
Racine.
Ravenswood.
Reedy.
Ripley.
Riverside Addition.
Roanoke.
Rockcave.
Rockford.
Rowlesburg.
St. Albans.
St. Marys.
Salem.
Sandyville.
Schultz.
Sedalia.
Seth.
Sherrard.
Shiloh.
Shinnston.
Shirley.
Shrewsbury.
Silverton.
Simpson.
Sistersville.
Smithburg.
Smithers.
Smithfield.
Smithville.
South Buckhannon.
Spencer.
Spring Hill.
Star City.
Stealey Heights.
Summit Park.
Sutton.
Tanner.
Terra Alta.
Thomas.
Thornton.
Three Mile.
Tin Plate.
Troy.
Tyler City.
Volcano.
Walgrove.
Walkersville.
Wallace.
Walton.
Ward.
Warwood.
Waverly.
Wayne.
Wellsburg.
West Fork.
West Hamlin.
Weston.
West Union.
Wheeling.
Wileyville.
William.
Williamson.
Williamstown.
Wilsonburg.
Woodlawn.
Woodsdale.
Woodville.
Worthington.
Wyatt.

WYOMING.

Basin.
Byron.
Greybull.

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BORAX.

By CHARLES G. YALE.

PRODUCTION.

In 1915 the production of crude borate materials in the United States was 67,003 short tons, valued at $1,677,099, compared with 62,400 short tons, valued at $1,464,400, in 1914, and 58,051 short tons, valued at $1,491,530, in 1913. All the crude borate material now used in this country is the mineral colemanite (calcium borate), and the output in 1915 came from a few mines in southern and southeastern California. The value of the product given is the value of the ore at the point of shipment estimated on a basis of $1 per unit (per cent) of anhydrous boric acid (boron trioxide, B_2O_3) in the raw material. All the ore shipped from California, however, was calcined or concentrated before being put on the cars at the mines.

A statement of the production of borax and borate materials in the United States (altogether from California and Nevada), compiled from the most authentic sources available, is given below:

Borate materials produced in the United States, 1864–1915.

Year.	Crude (short tons).	Refined (short tons).	Value.	Year.	Crude (short tons).	Refined (short tons).	Value.
1864	.....	12	$9,478	1891	.....	6,690	$869,700
1865	.....	125	94,099	1892	.....	6,750	900,000
1866	.....	201	132,538	1893	.....	4,350	652,425
1867	.....	220	156,137	1894	.....	7,340	974,445
1868	.....	32	22,384	1895	.....	5,959	595,900
1869	.....	0	0	1896	.....	6,754	675,400
1870	.....	0	0	1897	.....	8,000	1,080,000
1871	.....	0	0	1898	.....	8,000	1,120,000
1872	.....	140	89,000	1899	.....	20,357	1,139,882
1873	.....	1,000	496,000	1900	24,235	1,602	1,018,251
1874	.....	2,000	567,000	1901	17,887	5,344	1,012,118
1875	.....	2,717	672,000	1902	2,600	17,404	2,538,614
1876	.....	2,590	563,000	1903	34,430	.....	661,400
1877	.....	1,864	364,000	1904	45,647	.....	698,810
1878	.....	1,401	249,000	1905	46,334	.....	1,019,154
1879	.....	792	143,000	1906	58,173	.....	1,182,410
1880	.....	1,846	277,233	1907	52,850	.....	1,121,520
1881	.....	2,023	304,461	1908	25,000	.....	975,000
1882	.....	2,118	338,903	1909	41,434	.....	1,534,365
1883	.....	3,250	585,000	1910	42,357	.....	1,201,842
1884	.....	3,500	490,000	1911	53,330	.....	1,569,151
1885	.....	4,000	480,000	1912	42,315	.....	1,127,813
1886	.....	4,889	488,915	1913	58,051	.....	1,491,530
1887	.....	5,500	550,000	1914	62,400	.....	1,464,400
1888	.....	3,795	455,340	1915	67,003	.....	1,677,099
1889	.....	4,000	500,000				
1890	.....	4,750	617,500	Total	674,046	151,315	36,946,217

NOTE.—Prior to production from Nevada, prices ranged from 28 to 35 cents a pound for the refined borax extracted from the California lake waters. After 1872 the price dropped during the next two years to 6½ cents a pound; it then advanced slowly to 11 to 13 cents, but again fell off. In 1885 borax sold in San Francisco for 6 to 8 cents a pound; a further decline followed. From 1882 to 1903, inclusive, the refined product was used as a basis for estimating the value; but since 1904 the value has been estimated on a basis of unit values assigned to the boric acid in the crude product.

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As shown in the foregoing table, the production of borax in the United States began about 1864. It consisted of natural borax crystals found in California in the muds of the bottoms of two small lakes in Lake County. In the late seventies the native borax and the mineral ulexite in the marsh deposits in California and Nevada were utilized, but since the eighties the larger proportion of the American output has come from veins of colemanite.

The borax deposits are shown on the accompanying map (Pl. VII).

SOURCES OF DOMESTIC BORAX.

The production of borax in the United States continues to be derived entirely from California colemanite ores. The famous Lila C. mine of the Pacific Borax Co., in the mountains of the Death Valley region of Inyo County, after making a final small output early in 1915, was abandoned, and the company confined its efforts to the Biddy McCarty and Widow mines, two new properties opened and made productive in 1915. A small 18-inch tramway connects with the narrow-gauge line to the main line of railroad. At this property more rotary furnaces are to be put in. At the Lang property of the Sterling Borax Co., in Los Angeles County, the calcining plant has been enlarged and new deposits have been opened. New rotary Wedge furnaces have also been put in. The Stauffer Chemical Co., of San Francisco, did not make any production at the Russell borate mines in Ventura County in 1915.

Borax and borates imported for consumption in the United States, 1902–1915.

Year.	Borax.		Borates, calcium and sodium (crude) and refined sodium borate.		Boric acid.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1902	684,537	$20,795	186,807	$12,002	822,907	$30,439
1903	68,978	5,727	146,654	13,280	693,619	28,011
1904	153,952	10,569	89,447	6,630	708,815	27,658
1905	166,960	8,802	20,395	1,626	676,105	22,372
1906	791,425	27,343	57,711	2,436	986,021	33,200
1907	2,268,065	77,258	2,959	175	534,524	23,547
1908	641,632	22,058	40	4	385,064	14,702
1909	7,124	1,023	20,284	1,956	265,985	8,708
1910	6,860	1,170	563	66	336,466	11,164
1911	9,582	732	28,815	5,230	458,900	17,666
1912	9,280	636	16,091	1,861	232,545	8,752
1913	4,215	477	7,900	1,025	423,215	16,932
1914	220	29	3,862	546	425,241	18,837
1915	.....	.....	2,748	393	442,078	20,889

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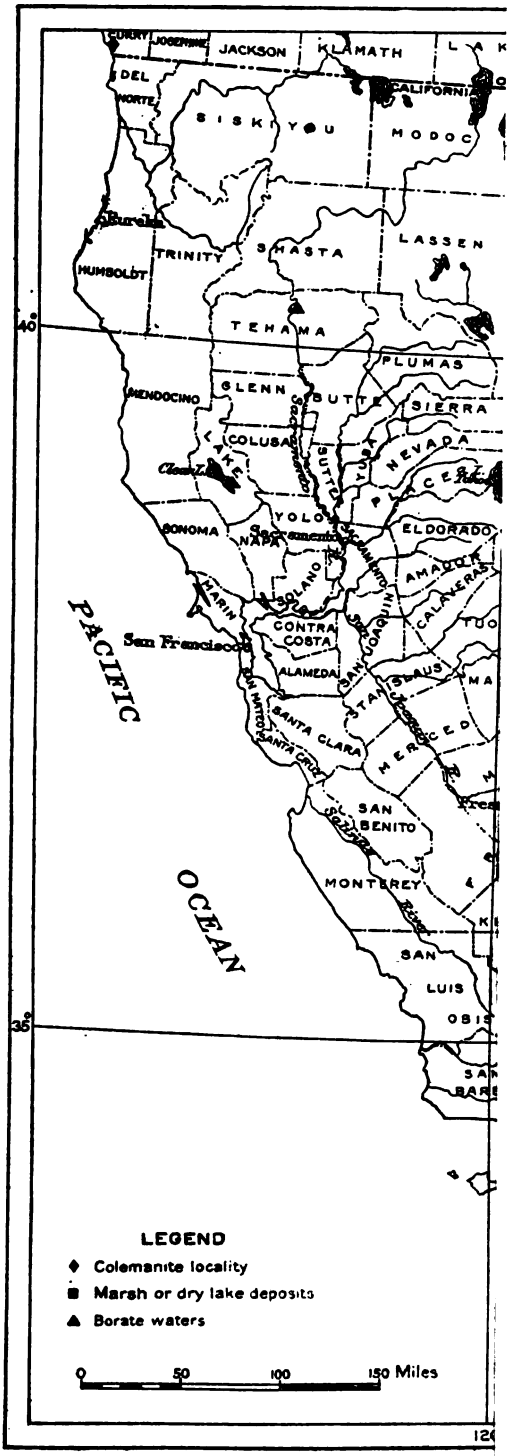
U. S. GEOLOGICAL SURVEY



MAP SHOWING BORAX DEP

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MAGNESITE.

By CHARLES G. YALE.

GENERAL CONDITIONS.

Conditions brought about by the European war, especially those affecting ocean traffic, had a marked influence on the magnesite industry of the United States during 1915. It has been necessary for American consumers to depend largely on domestic mines and to pay higher prices for their supplies. Thus far California alone has been able to furnish this mineral on a commercial scale, and to meet the demand the mines in that State made the largest output in their history in 1915, much more than doubling their output in any previous year. Moreover, since the end of 1915 a large number of new California mines have been developed and brought to a productive stage and owing to local lack of furnace capacity for calcining have been shipping considerable crude ore in bulk by rail across the continent. The freight rates by rail from San Francisco to Chicago were $10 a ton; to Illinois and Ohio points, $11; and to Pittsburgh and beyond, $12. Owing to lack of bottoms little or no magnesite has been shipped through the Panama Canal to the Atlantic seaboard.

The average price per ton at San Francisco in 1915 was from $8 to $9 for crude ore and $22 to $25 for calcined ore, although contracts at lower prices were made with the larger producing mines. These prices plus freight rates have made the use of domestic magnesite expensive to those who have been accustomed to purchase the imported material.

The Austrian and Hungarian magnesite formerly imported contains 6 to 8 per cent of iron; it is therefore more available for furnace use than the purer magnesite obtained in many other parts of the world; moreover, it can be produced more cheaply and in larger quantities and is more readily manufactured into refractory brick than the purer material. Until the cutting off of this supply, more than 90 per cent of the magnesite consumed in the United States was derived from these countries.

The California magnesite deposits carry a purer material than the Austrian and Hungarian, and their output is better adapted for making paper, tiling, flooring, and cements than for refractory use. There is one mine recently reported in the State, in Napa County, whose product carries iron and corresponds nearly in composition

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to the ore from Austria. The mine is equipped with a calcining plant, but its entire output is absorbed by local steel plants. The deposits at a few other mines have smaller percentages of iron but more silica and lime. Magnesite is not in demand when it carries more than 5 per cent of silica and 3.5 per cent of lime.

When the demand was made upon California for large supplies of magnesite there were less than half a dozen mines in operation prepared to supply more than a few hundred tons a month, and these had contracts up to the capacity of their calcining plants with the manufacturers of paper on the Pacific coast. It had previously been impossible to ship magnesite from California to the Atlantic seaboard in competition with the foreign supply because of the cost of freight. The consumption on the Pacific coast was annually no more than 6,000 to 7,000 tons, and there was little encouragement to open any of the numerous known undeveloped deposits. In fact, it had not been profitable to open any California mine which was more than a few miles from main-line railroad facilities. The new demand for California magnesite has, however, caused mines 20 miles from railroad stations to be developed; and even old mines, long idle, have been reopened and brought to a productive stage.

This stimulation in the magnesite industry in California began in the latter part of 1914, but at first it affected chiefly the larger properties. There was more or less speculative inquiry for unopened deposits, but there was no apparent disposition for permanent investment in mines and plants. Toward the end of 1915, however, and early in 1916 many deposits in California passed into the hands of men financially able to open them properly and to put the product on the market. In Napa and Sonoma counties properties long known as available were purchased and made productive. In Tulare County, in San Joaquin Valley particularly, prospectors searched in all directions for magnesite, and numerous small deposits near Porterville and Exeter were worked on the leasing system, the product being sold for cash to larger operators, who shipped it to the East.

Offers for large quantities were made to California producers, but at first the prices were too low to be attractive. Later, when no more imported material was available, much higher prices were offered, which led to rapidly increased production, to the opening of numerous deposits, and to the building of new calcining plants. Since the end of 1915 a few of the larger deposits of California, hitherto unworked by reason of distance from trunk lines of railroads, have passed into the hands of new owners who are constructing branch lines to the mines. This will lead to greatly increased production; but were all the known deposits in California brought to their capacity of production, it would be difficult for them to furnish the magnesite needed annually in the United States for refractory purposes. They could easily meet, however, in both quantity and quality, the domestic demand for the purer grades of magnesite used for paper, cements, paints, fireproof and damp-proof coatings, and other products.

The report on magnesite in Mineral Resources for 1914 contained some discussion of the character of the mineral and its derived products and uses, and a map was included showing the distribution of the deposits in California. That report is still available for free dis-

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tribution by the United States Geological Survey in Washington and at the Survey offices in Denver and San Francisco, and may be had on application.

PRODUCTION.

The crude magnesite produced and sold or treated in the United States in 1915 amounted to 30,499 short tons, valued at $274,491, as compared with 11,293 short tons, valued at $124,223, in 1914.

The domestic material continues to be derived from California exclusively, and was obtained in 1915 from 16 mines in the counties of Alameda, Fresno, Kern, Napa, Santa Clara, Sonoma, and Tulare. The principal producing mines were those of the Tulare Mining Co., Tulare County; Rex Plaster Co., Kern County; and Western Magnesite Development Co., Santa Clara County. A number of the other properties which contributed to the total output became productive only toward the end of 1915. All the magnesite from the larger properties is calcined in their own furnaces before being marketed.

Crude magnesite produced in the United States, 1891–1915.

	Quantity (short tons).	Value.		Quantity (short tons).	Value.
1891	420	$4,390	1904	2,850	$9,298
1892	1,004	10,040	1905	3,933	15,221
1893	704	7,040	1906	7,805	28,415
1894	1,440	10,240	1907	7,561	22,683
1895	2,290	17,000	1908	6,587	19,761
1896	1,500	11,000	1909	9,465	37,860
1897	1,143	13,671	1910	12,443	74,658
1898	1,263	19,075	1911	9,375	75,000
1899	1,280	18,480	1912	10,512	84,096
1900	2,262	19,333	1913	9,632	77,056
1901	3,500	10,500	1914	11,293	124,223
1902	2,830	8,490	1915	30,499	274,491
1903	3,744	10,595			

The value assigned to the domestic product in 1915 is based on a price of $22 to $25 a ton of ordinary calcined magnesite, not ground, in sacks at San Francisco, which is assumed to be approximately equivalent to $9 a ton for the raw or crude magnesite at the same point. The ground magnesite brings a somewhat higher price in California markets, but the imported magnesite sells at a price above that of the domestic product, the reason being that the imported magnesite is more finely ground, is put up in better packages, and may be purchased in smaller lots on longer credit than the domestic.

DEVELOPMENTS.

CALIFORNIA.

Alameda County.—The only productive magnesite mine in this county in 1915 was the Cedar Mountain, and only small shipments were made from it. There are several small deposits in the mountains near Livermore, but none were productively worked in 1915.

Fresno County.—The Levensaler-Speir Corporation operated under lease and royalty the L. H. Ward mine, at Piedra, but only a small

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quantity of crude magnesite was produced during the year. The Fresno Magnesite Co., at the same place, carried on extensive development work, but, although equipped with calcining furnaces, it made no output.

Kern County.—One of the most productive magnesite mines in the State is that of the Rex Plaster Co., of Los Angeles, near Bissell station. The property is worked under secondary lease from the Southern Pacific Co., which owns the land. The quarry at Bissell is about 1 mile from the railroad, and the material is hauled to the railroad by teams. There are no kilns at the mine, but there is one in Los Angeles, to which the crude magnesite is shipped for calcining. The capacity of the kiln is 1 ton of calcined product per hour. The calcined material was nearly all shipped to the large refractory companies in the East and the Middle West, although some was sold to local consumers. Since the end of 1915 the Rex Plaster Co. has acquired a deposit near Porterville, the magnesite from which is utilized to "enrich" that from the Bissell quarry. A narrow-gage railroad was built from the mine on the Avery tract to the main line.

Napa County.—There were few productive mines in this county in 1915, but several have recently (1916) been opened and have commenced shipping magnesite. Of the producers in 1915, the White Rock mine, in Pope Valley, had the largest output and shipped the magnesite crude. The Tulare Mining Co., of Porterville, reopened the old Chiles Valley mine, 12 miles east of Rutherford, and shipped crude magnesite east for the first time in the history of the State.

Placer County.—No output was made in 1915 from any of the deposits at Iowa Hill, Damascus, or Towle, and very little development work was done. Some new "prospects" have been found on the bank of Little Bear River and at Remington, across Bear River, but they have not been opened. The deep snow that covered the ground soon after the discovery prevented development work until the summer of 1916. The Placer County properties were not operated.

Riverside County.—The mines at Winchester, owned by the Magnesco Refractory Co., of Los Angeles, and formerly productive, made no output in 1915. They were leased to W. Wells & Co., of New York, and experiments have been made in the direction of manufacturing brick, both refractory and paving, the paving brick being made by a mixture of magnesite, serpentine, and river sand. Some exploration work was done at the mine, and several shafts encountered material of the same character as that found in the open cut from which magnesite was formerly obtained.

Santa Clara County.—The principal producing magnesite mines on the east side of San Francisco Bay in this county are those owned by the Western Magnesite Development Co., whose properties are on Red Mountain, at the junction of the boundary lines of Alameda, Santa Clara, and Stanislaus counties. These properties were listed under Alameda County in the report for 1914, but the mines that produced in 1915 are within the lines of Santa Clara County. They are about 35 miles from the main line of railroad at Livermore, from which Alameda County has constructed a fine road to the mines. The ore is calcined in the furnaces at Red Mountain and hauled by motor trucks to the railroad station at Livermore. This

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company made large shipments of magnesite in 1915 and has since materially increased them. A railroad is being built from Patterson, in Stanislaus County, by another company to furnish transportation for certain other mineral substances, and this will terminate within a few miles of the properties of the Western Magnesite Development Co. Arrangements may therefore be made to ship by this line. The Pacific Magnesite Co. owns undeveloped properties adjoining those of the Western Magnesite Development Co. and expected in 1915 to begin production in 1916. There are also other magnesite deposits in this vicinity that have not yet become productive. On the western shore of San Francisco Bay, near Madrone, in Santa Clara County, the Glen Willows quarry was worked by H. Sherlock, who shipped crude magnesite to the Pure Carbonic Co., of Berkeley, where it was calcined, the carbonic acid gas was utilized, and the calcined material was sold to paper mills in Oregon. This mine has since been given up, and Mr. Sherlock has opened another mine in the same vicinity, from which he is shipping. Another productive mine near Madrone is that owned by the Bay Cities Water Co., at which the magnesite was hand sorted and shipped crude, there being no furnaces on the property. The Snyder claim, near Morgan Hill, was not operated during the year.

San Bernardino County.—No developments of note have been made on the deposits in the vicinity of Victorville, Bagdad, or Crescentia, although a carload was shipped to Newark, N. J., from Magnesite siding, in this county, for experimentation.

Sonoma County.—The most productive mine in this county is that of the Sonoma Magnesite Co., near Cazadero, where a rotary kiln has been installed. The narrow-gage railroad from the trunk line was not finished until March 15, 1916, and the haul by auto to the railroad was 13 miles. Only calcined material was shipped in 1915, but since then crude magnesite carrying about 2.5 per cent iron has been shipped. Most of the shipments have gone to New York for furnace lining. The Magnesite Products Co., of San Francisco, built a plant to make plaster, stucco, and flooring, and it intends to manufacture magnesium chloride also. The Yordi Ranch mine, near Cloverdale, and the Shaw & Matthews mines, in the same neighborhood, were small shippers during the year. The Refractory Magnesite Co., near Preston, which began developing the old Creon mine in July, 1915, shipped its product to be calcined at a furnace in East Oakland, Alameda County, but by April, 1916, it had erected a furnace at the mine. The dead-burned magnesite from this mine is in much demand, as it carries 6.44 per cent iron, 1 per cent silica, and no lime, in this regard resembling the Austrian product. The Madeira and Lucky Elsie mines, owned by George Madeira, of Healdsburg, made no production in 1915, and one of them was sold. Nothing was done with the Mountain Lion, near Cazadero.

Tulare County.—The largests output of magnesite in California—and in the United States—has been coming from Tulare County for many years. The most productive mine is that of the Tulare Mining Co., on South Fork of Tulare River, 10 miles east of Porterville, where there is rail connection to the Southern Pacific main line. This mine is equipped with two vertical furnaces, one of which was recently erected. Most of the product is calcined for use in the manufacture of paper on the Pacific coast, but some is ground and

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sold for plastic purposes, and some shipments have been made to Eastern States. The Porterville Magnesite Co., of California, began opening the Harker or Western Carbonic Gas Co. deposit of magnesite in November, 1915, and some shipments of crude magnesite were made in that year. Greater activity has been manifested since that period, and a 60-foot rotary kiln has been installed. Most of the magnesite is shipped to paper mills in Oregon. These were the only large producers in the Porterville region in 1915, although small shipments were made from the Balam & Pingee lease on the California Magnesite Co.'s mine at Porterville, and some from the Joyner Claim at Exeter. No output was made in 1915 by the Hathaway, Howeth, Smith, Avery, Cook & Langley, or Adams properties, or those of the California Magnesite Co., or of the Success Mining Co., although these have since become productive.

NEVADA.

No production of magnesite has been made in Nevada. A large deposit in Clark County, on Muddy River, near St. Thomas, contains magnesite running high in lime and silica, but no commercial shipments have been reported. A new deposit near Goldfield is reported by D. L. Richie, of that place. It is undeveloped, affording no indication of the quantity of material present.

FOREIGN.

Canada.—It was reported that a mine near Skagway, Alaska, was shipping magnesite to the United States, but inquiry of the Canada Geological Survey, Department of Mines, elicited the fact that the shipments through Skagway came by way of the White Pass & Yukon Route from mines at Atlin, British Columbia. Some hundred tons of this material was sent to Vancouver.

Mexico.—The International Magnesite Co. resumed shipments of crude magnesite from the deposits in Santa Margarita Island in the Gulf of California, the material being brought by sea to the rotary kiln calcining plant on San Diego Bay, Cal. Shipments have been intermittent and irregular owing to the difficulty of obtaining vessels.

INDUSTRIAL UTILIZATION.

The following notes pertain to new features in the industrial utilization of magnesite that have been brought to attention during the year:

It is learned from the managers of the Western Magnesite Development Co. that their product, which is very pure and without iron, is used, after mixing with 10 per cent of slag from steel furnaces, for furnace lining.

The Western Metals Co., of Los Angeles, which is operating a smelter near that city for antimony ores, uses magnesite from the Bissell deposit for lining its fire-brick furnaces. The bottoms are lined with ordinary dead-burned magnesite, tamped in a moist condition, without binder. Corrosion takes place on the side walls only, for the plastic or fine-ground magnesite is mixed with a solution of sulphate of magnesia, and this with the coarser dead-burned mag-

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nesite, and the mixture is laid on the walls by plastering to make a body. The outer brick wall of the furnace is thus lined with 5 inches of plastering at the top and 9 inches at the bottom. This inner wall lining is monolithic. The sulphate solution is made by dissolving a pound of sulphate of magnesia crystals in a pint of water, making about a pint and a third of solution. The concrete mixture above described for the walls requires about eight hours to set hard, after which it should stand a week to dry out before firing and be fired gradually. For the furnace roof molds are used to make blocks of the mixture described, and the blocks are allowed to stand a week or two before using. One part of the ground plastic to two parts of the dead-burned grain magnesite is used.

PRICES.

It is difficult to name an average price which may be said to represent the market in 1915. In the returns received by the United States Geological Survey from producers, a considerable range in price is shown, according to character of ore and distance from railroad. The crude magnesite was sold as low as $5.50 and as high as $10 per ton by producers. The average was probably between $8 and $9 per ton. The calcined magnesite, unground, in sacks, brought in San Francisco from $22 to $25 per ton, but in the earlier part of 1915 some of the calcined fine-ground imported brought as high as $50 to $60 per ton. In New York and Philadelphia little or no business in foreign magnesite was done, and the few receipts of California magnesite were so disposed of that no record of prices was to be had. Therefore, only prices on the Pacific coast, where the domestic product originates, are quoted.

Prices per short ton of magnesite in 1915 in San Francisco or Los Angeles markets.

Domestic, calcined, not ground (in sacks)	$22–$25
Domestic, calcined "caustic," fine ground (in paper-lined barrels)	40– 55
Austrian and Grecian, calcined, dead burned, fine ground	40– 60

IMPORTS.

The following statistics of imports of magnesite are obtained from the Bureau of Foreign and Domestic Commerce, Department of Commerce:

Magnesite imported for consumption in the United States, 1913–1915.

	1913		1914		1915	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Magnesia:						
Calcined, medicinal	54,915	$10,034	159,547	$19,342	94,309	$10,451
Carbonate of, medicinal	70,823	4,880	46,183	2,527	48,817	2,757
Sulphate of (Epsom salts)	8,121,677	32,894	13,826,899	53,768	3,560,701	16,050
Magnesite:						
Calcined, not purified	334,187,404	1,672,565	243,633,205	1,323,194	53,148,739	232,071
Crude	26,479,109	84,911	26,708,381	54,677	99,527,772	255,140

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Magnesite calcined, not purified, imported into the United States, fiscal years ending June 30, 1913–1915, in short tons.

Country.	1913	1914	1915
Europe:			
Austria-Hungary	163,715	134,260	52,086
Belgium		11	
Germany	2,412	2,578	722
Greece	1,605	3,232	4,437
Denmark		58	103
Italy			710
Netherlands	4,508	4,191	3,554
United Kingdom:			
England	1	12	129
Scotland		1	150
North America: Canada	350	404	948
South America: Venezuela			508
	172,591	144,747	63,347

Magnesite imported into the United States, fiscal year ending June 30, 1915, in short tons.

Customs district.	Crude.[a]	Calcined.
Maryland	527	689
Massachusetts	27	2,505
New York	6,191	10,856
Philadelphia	11,189	31,152
San Francisco	53	
St. Lawrence	743	603
Michigan	1	64
New Orleans		11,115
Southern California		83
Washington		100
Ohio		30
Vermont		60
	18,731	57,348

[a] Imports for consumption.

The total imports fell off materially in 1915, as compared with 1914, owing to the European war. In the last months of 1914 and in the first two months of 1915 the shortage in this country caused somewhat unusual shipments. Since March, 1915, no Austrian magnesite has been received in the United States. The New York market price for Austrian dead-burned magnesite at the beginning of 1915 was rather indefinite but may be stated at $25 to $26 per short ton. The Grecian imports, according to the table given, increased about 25 per cent in the period named. The Grecian shipments were intermittent. The greater part of the magnesite that has come into the New York market since August, 1915, has been from California.

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PEAT.

By JAMES S. TURP.

INTRODUCTION.

The report on peat, published annually in Mineral Resources, was prepared for a number of years by Mr. C. A. Davis, formerly of the Survey but recently of the Bureau of Mines. His death, in April, 1916, was a misfortune to those connected with the peat industry; they lost not only one of the best authorities on peat in the United States but also one of the industry's best friends.

For data used in compiling the present report the author is indebted to the cordial cooperation extended by the producers of peat, for which he expresses his appreciation. The outline used by Mr. Davis has been followed, in general, and liberal use has also been made of the information contained in the reports prepared by him.

DISTRIBUTION OF PEAT IN THE UNITED STATES.

The distribution of the domestic deposits of peat has been thus described by Davis:[1]

> In the United States the regions most favorable for the occurrence of deposits of peat are in the States lying east of about the ninetieth meridian and north of an irregular line following the southern margin of the last or Wisconsin glacial drift. This line runs nearly due east across north-central Iowa, Illinois, Indiana, and Ohio, and, after dipping southward a short distance along the Appalachians, turns northeastward across Pennsylvania and New Jersey nearly to the coast. Peat deposits are also of frequent occurrence in the region extending southward from New Jersey along the Coastal Plain to and including Florida. In the regions of heavy rainfall along the Pacific coast peat deposits occur wherever the drainage is sufficiently interrupted to allow the soil to be flooded or permanently saturated by water. The States known to have the most extensive peat deposits are Florida and those along the northern border as far west as North Dakota.

A map compiled by Davis[2] shows the distribution of deposits of peat in the United States, approximate location of plants for the utilization of peat beds, and other data.

UTILIZATION OF PEAT IN THE UNITED STATES.

In spite of the many uses of peat in European countries and of the extensive deposits in the United States, the domestic material has only recently been produced on a commercial scale for any purpose.

[1] Davis, C. A., Peat: U. S. Geol. Survey Mineral Resources, 1914, pt. 2, p. 376, 1915.
[2] Davis, C. A., The uses of peat for fuel and other purposes: U. S. Bur. Mines Bull. 16, pl. 1, 1911.

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PEAT AS FUEL.

Many attempts have been made in this country, with almost uniform lack of success, to manufacture fuel from peat. The reasons for failure of such enterprises have been manifold, but so far as can be determined by careful inquiry the failure has not been caused by inability to sell the product, but generally by other factors, among which may be mentioned inexperience of operators, inadequate machinery, and lack of sufficient capital.

Robert Blei,[1] in a paper read at the eighth annual meeting of the American Peat Society, at Duluth, in August, 1914, describes a process for the manufacture of peat briquets essentially as follows:

> To the air-dried peat is added crude oil, dextrine, and lime, and the mixture is compressed into briquets, which are hard, dense, black, durable, unbreakable in transportation, and burn freely with a long, clear flame. * * *
>
> The process produces an artificial coal yielding 10,000 to 11,500 British thermal units per pound, according to the amount of crude oil added, the cost for binder being only 8 cents per ton, and the cost of the finished fuel being about $1.15 to $2.15 per ton. * * *
>
> The briquets produced by the Herbein process have been thoroughly examined and passed on by engineers the world over, and I feel that in presenting this fuel I lay before you a form of peat fuel that the peat industry has dreamed of and has striven to produce in this country and in Europe.

The company interested in this process reported no production in 1915. They report, however, that plans are made to complete the plant so that operation may begin early in 1917.

In 1915 no peat-fuel plants were reported in operation, whereas in 1914 there were four such plants which had an estimated production of 1,925 short tons of air-dried machine peat. Of the plants reporting in 1914, one has been absorbed by another concern that is installing an extensive plant with a view to operation during the later part of 1916; another expects to resume operation in the summer of 1917; and the other two have merely reported no production. It seems likely, therefore, that there will be little or no domestic peat produced for fuel in 1916, but that 1917 will witness a resumption of peat-fuel operations in this country.

PEAT AS FERTILIZER AND FERTILIZER FILLER.

The most successful industry based on peat so far attempted in the United States is that of preparing peat for use as a fertilizer or as a filler for chemical fertilizers. Black, thoroughly decomposed peat is most satisfactory for all fertilizer uses, as such peats are generally heavier and more compact and contain more nitrogen and less fibrous material than the brown types. Some of the peat sold during 1915 for direct use as fertilizer was enriched by the addition of beneficial soil organisms.

The production of peat for fertilizer and fertilizer filler during 1915, as reported, was 38,304 short tons, valued at $258,447, as compared with 37,729 short tons, valued at $249,899, in 1914. The selling prices given varied widely according to the grade of the product, the uses to which it was to be put, the quantity and quality of the materials added, and the size of the selling unit. The lowest price per ton reported was $3, the highest $16, and the average $6.75.

[1] Blei, Robert, The Herbein process for making briquets from peat, petroleum, and binder: Am. Peat Soc. Jour., vol. 8, No. 4, pp. 83–85, October, 1915.

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The following table shows that in only two years, 1911 and 1912, since these figures were first published by the Geological Survey, has the production of peat for fertilizers been greater than in 1915. The most striking feature, however, is that although the production in 1911 was nearly 13,500 tons in excess of that in 1915, the value in 1915 was more than $1,000 in excess of the value in 1911.

Peat used for fertilizers produced in 1908–1915.

	Quantity (short tons).	Value.		Quantity (short tons).	Value.
1908	23,000	[a] $121,210	1912	41,080	$186,022
1909	26,768	118,891	1913	28,460	169,600
1910	37,024	140,209	1914	37,729	249,899
1911	51,733	257,204	1915	38,304	258,447

[a] Estimated.

Requests for information regarding the use of peat strictly as a fertilizer should be addressed to the Chief, Bureau of Plant Industry, Washington, D. C.

PEAT LITTER.

No peat litter has been produced in the United States for several years. As in previous years, however, a certain quantity was imported in 1915 under the name of "peat moss." The entire importation was 7,514 short tons, valued at $48,142, or $6.41 per ton, an increase in value per ton over 1914 of $0.61, but a decrease in total quantity of 2,407 tons and in total value of $9,400.

OTHER USES OF PEAT IN 1915.

Only two other uses of peat were reported by producers in 1915—as an ingredient of stock food and as used by florists. The quantity shipped for the latter use was reported by the producer with the peat for fertilizer. The single firm that has for some years reported production of peat for making paper failed to answer inquiries for 1915, and the firm that reported peat for mud baths in 1914 gave no such production in 1915.

Two firms reported the production of peat for stock food, the total amounting to 3,980 short tons, valued at $30,090, or an average price of $7.56 per ton. It is stated by one of the producers that the results obtained by the use of peat in such foods have proved very satisfactory, the peat acting as a tonic and a corrective. The kind of peat so far used in this country for the purpose is of the black, well-humified type.

PRODUCTION.

During 1915 no new processes or machinery for preparing peat were reported to have been commercially tried in the United States, but several firms reported additions and improvements to their plants, some with a view to increased production. The whole number of plants reporting production was nine, all of which sold peat for fertilizers and two of which also sold peat for stock food. Seven firms that furnished data for 1914 furnished none for 1915, and two firms reported that were not represented in 1914. Of the seven not reporting production in 1915, four are the peat-fuel plants,

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one is the paper manufacturer mentioned above, one has discontinued the production of peat, and the other plant was sold.

The nine plants known to be at work during the year were distributed as follows: Massachusetts, 1; New York, 1; New Jersey, 3; Pennsylvania, 1; Florida, 1; Illinois, 2.

The quantity of peat products made and used in the United States in 1914 and 1915, so far as these have been reported, are given below. In the statement for 1915 the peat sold for fertilizers is given under one heading, as from the reports submitted it is impossible to separate definitely the quantity sold for use as direct fertilizer from that sold for use as fertilizer filler.

Peat produced, imported, and consumed in the United States in 1914 and 1915.

Use.	Production.		Imports.		Consumption.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1914.						
Fertilizer filler	22,767	$136,994	.....	.....	22,767	$136,994
Fertilizer	14,962	112,905	.....	.....	14,962	112,905
Fuel	1,925	6,540	.....	.....	1,925	6,540
Miscellaneous [a]	7,439	53,253	.....	.....	7,439	53,253
Peat moss litter	.....	.....	9,921	$57,542	9,921	57,542
	47,093	309,692	9,921	57,542	57,014	367,234
1915.						
Fertilizer and fertilizer filler	38,304	258,447	.....	.....	38,304	258,447
Stock food	3,980	30,090	.....	.....	3,980	30,090
Peat moss litter	.....	.....	7,514	48,142	7,514	48,142
	42,284	288,537	7,514	48,142	49,798	336,679

[a] Only 1 producer each of peat for stock food, mud baths, and paper pulp.

BIBLIOGRAPHY.

SURVEY PAPERS ON PEAT.

The following list includes the publications on peat issued by the United States Geological Survey. The publications to which no price is affixed may be obtained free by applying to the Director, United States Geological Survey, Washington, D. C. The priced publications, except the folios, may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C.; the folios are for sale by the Survey.

BASTIN, E. S., and DAVIS, C. A., Peat deposits of Maine: Bull. 376, 127 pp., 1909. 20 cents.

BASTIN, E. S., and WILLIAMS, H. S., Geol. Atlas, Eastport (Maine) folio (No. 192), 1914. 25 cents.

BAYLEY, W. S., and others, Geol. Atlas, Raritan (New Jersey) folio (No. 191), 1914. 25 cents.

DAVIS, C. A., The possible use of peat fuel in Alaska: Bull. 379–A, pp. 63–66, 1909.

——— Peat resources of the United States, exclusive of Alaska: Bull. 394, pp. 62–69, 1909. 40 cents.

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SHALER, N. S., Origin, distribution, and commercial value of peat deposits: Sixteenth Ann. Rept., pt. 4, pp. 305–314, 1895. $1.20.

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DAVIS, C. A., The uses of peat: Bull. 16, 214 pp., 1911. Applications for this bulletin should be addressed to the Director, Bureau of Mines, Washington, D. C.

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ARTIFICIAL GAS AND BY-PRODUCTS.[1]

By C. E. Lesher.

INTRODUCTION.

Gas as a fuel has become almost indispensable to civilization and as a source of illumination in urban and suburban life it is now the only strong competitor of electricity. The ease and convenience with which gas can be used and controlled, its cleanliness, and its cheapness make it the ideal fuel for use in the household, in steam plants, and in metallurgical works. Gas, particularly that made in gas producers and in iron furnaces, is also used for fuel in internal-combustion engines.

This report deals with artificial gas[2] made from bituminous coal and oil by distillation and from anthracite and coke by what is known as the water-gas process. Producer, blast-furnace, acetylene, Pintsch, and other gases are not included. Except the greater part of the gas from the by-product coke ovens, all the gas considered in this report was made in plants operated for municipal supply. Gas is the principal product of these plants and the ammonia, tar, and coke are by-products; coke is the principal product of most of the by-product plants and gas is a by-product.

So far as has been possible the statistics have been arranged to show the production and sales of gas of the three kinds—coal, oil, and water—by the three uses—illumination, domestic fuel, and industrial fuel—and by States. In many of the States the number of producers of gas of one kind is less than three, and in order not to disclose individual reports it has been necessary to combine the information by grouping the States according to the geographic subdivisions adopted by the United States Census.

REVIEW OF THE ARTIFICIAL-GAS INDUSTRY.

The progress of the artificial-gas industry in the period 1898–1915 is shown graphically in the accompanying figures.[3] The smallest increase in this period was recorded in the manufacture of coal gas, the largest in the production of by-product coke-oven gas. The total consumption of coal gas in the period increased roughly in proportion to the increase in population in the United States, but the quantity of oil gas and water gas consumed shows a much more

[1] Previous reports on this subject were published in Mineral Resources for the years 1898, 1902, 1903, 1904, 1905, 1907, 1908, and 1912. The statistics for 1915 in this report were compiled by Mrs. H. L. Bennit, statistical clerk.

[2] For statistics of natural gas, see current report in this series.

[3] No statistics of oil gas and water gas were collected by the Geological Survey in the years between 1898 and 1905, and the curves are projected across this interval in figure 32. In all the diagrams the curves are interpolated for the periods between the years for which statistics are available.

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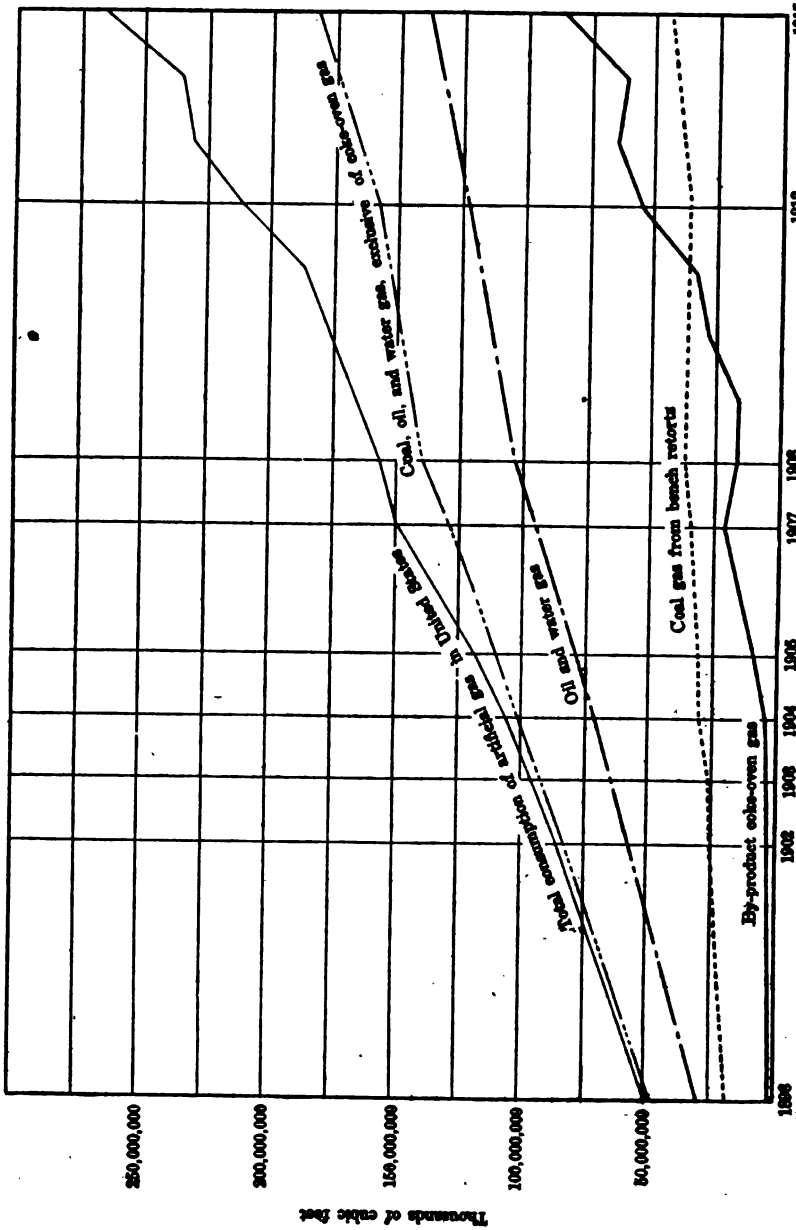

Figure 83.—Consumption of artificial gas in the United States, 1898–1915. (Producer gas, Pintsch gas, acetylene gas, blast-furnace gas, and other gases not included.)

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rapid though uniform rise. The quantity of both coal gas and water gas consumed increased at a more rapid rate from 1898 to 1908 than from 1908 to 1915, and, as will be shown later, the year 1908 appears to mark a turning point in the history of the artificial-gas industry. From 1898 to 1904 the surplus gas from by-product coke ovens was comparatively small; it did not exceed that made in the old-style coal-gas plants until 1911; but in 1915 the surplus gas from by-product coke ovens was nearly twice the quantity manufactured in coal-gas plants. In the 17 years from 1898 to 1915 the consumption of artificial gas from by-product coke ovens and from coal, oil, and water gas plants increased more than fivefold.

The uses of artificial gas, as they appear in the statistics in this report and in preceding reports of this series, are shown graphically in figure 33. The most significant points brought out in this diagram are the increasing use of artificial gas for fuel, and since 1908 its decreasing use for illumination. Furthermore, it is seen that there has been little change in the total quantity of coal gas used for illumination, but a large increase in the use of coal gas for fuel—the result of the greater number of by-product coke ovens in operation. The quantity of oil gas and water gas used for illumination was greatest in 1908, and in 1915 it had decreased to less than it was in 1905.

It is believed that an explanation of the greater decrease in the use of oil gas and water gas for illumination, as compared with coal gas, is found in the fact that in the larger cities water gas is the product almost exclusively supplied and that it is in the large cities that electricity has come into more general use for illumination, gas for that use suffering by the competition offered. The upward trend of prices of coal, particularly of anthracite, and the education of householders in the use of gas for cooking, heating water, and to a limited extent for heating houses (as in fireplaces and by small stoves) have undoubtedly favored the use of gas for domestic purposes other than illumination and account in part for the large increase in the consumption of artificial gas for fuel. This is shown more especially in the statistics of water gas in figure 33. The greater part of the coal gas consumed for fuel is used in the industries and comes from the by-product coke ovens.

The difference in the average capacity of water-gas and coal-gas plants (exclusive of coke ovens) and the increase in size are exhibited in figure 34, which shows the average output of gas from plants of the two kinds in the years for which statistics are available. As previously noted, the larger cities are served by water-gas plants and the smaller cities and towns by coal-gas plants. The increase in capacity is probably to be explained by the increase in the size of cities and in urban population in general.

Mere aggregation of population tends to increase average consumption. As pointed out by Watkins and Lubarsky,[1] the public appears to be able quickly to obtain for itself most of the benefit of density of consumption of gas by means of lower price. The importance of the relation of average price and of consumption of gas per capita to population is clearly shown in figure 35. In this diagram the per capita consumption of all gas, exclusive of that from by-product coke

[1] Watkins, G. P., and Lubarsky, L. H., Consumption of gas as affected by population: Am. Stat. Assoc. Quart., new ser., No. 116, pp. 405-417, December, 1916.

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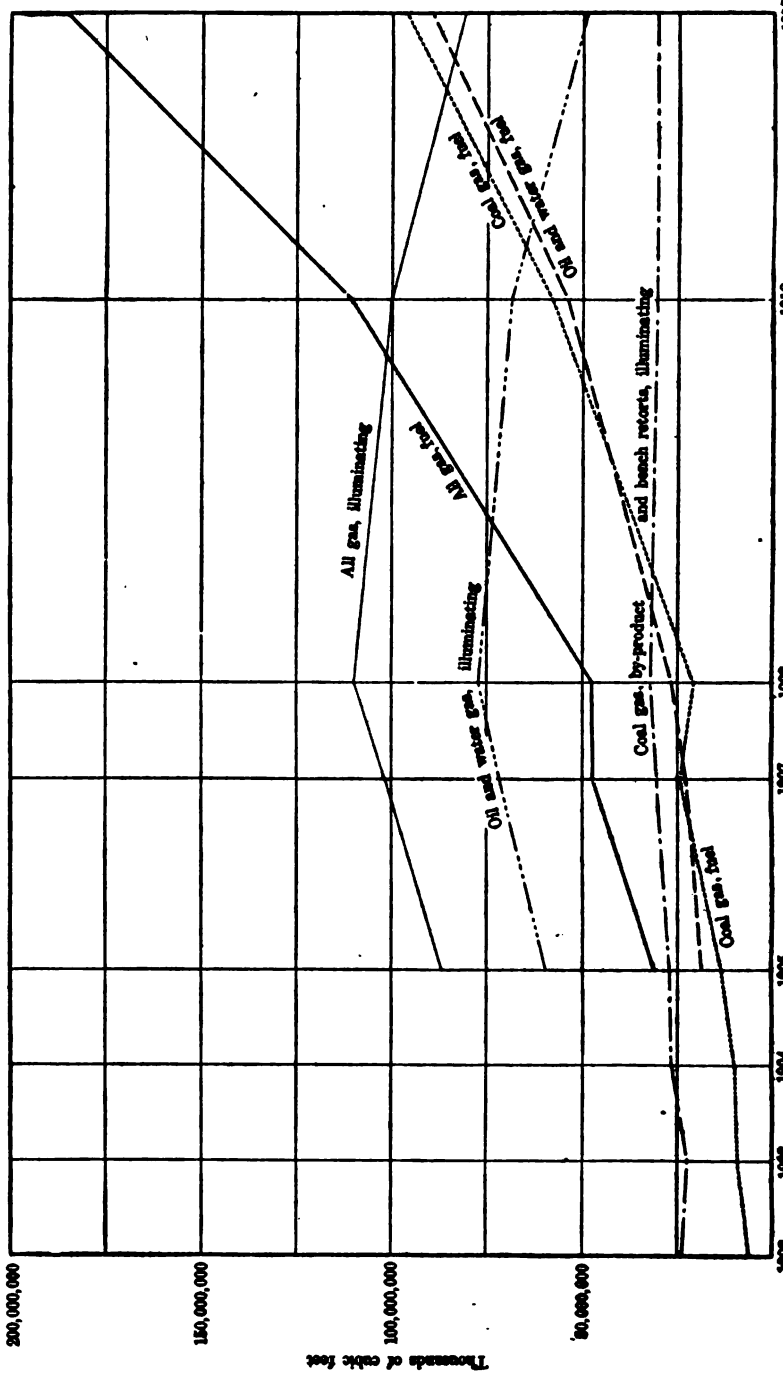

FIGURE 33.—Consumption of coal gas from by-product coke ovens and bench retorts and of oil gas and water gas in the United States for illumination and for fuel, 1902–1915.

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ovens, and the average price to the consumer are plotted as dependent variables with respect to the population of the United States. Gas from by-product coke ovens is excluded from this computation because until of late years it has been and is even now used in large part as industrial fuel and because, as explained on page 1041, the price is reported on a basis not comparable to that on which the price of water gas and coal gas from retorts is determined. The consumption per capita rose from 676 cubic feet in 1898 to 1,580 cubic feet in 1908, and in that period the ratio of increase was nearly uniform. In the same period the average price of coal gas decreased from $1.17 per thousand cubic feet in 1898 to 93 cents per thousand in 1908 and the price of water gas decreased at approximately the same rate.

From 1908 to 1915, or in seven years, the population of the United States increased 11,000,000, compared with an increase of 16,000,000 in the 10 years preceding 1908. The consumption per capita increased from 1,580 cubic feet in 1908 to 1,809 cubic feet in 1915, or an average

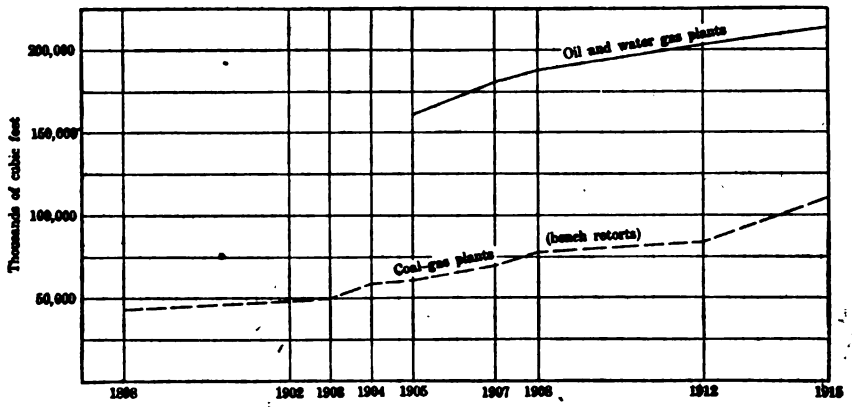

FIGURE 34.—Average production per plant of coal-gas plants (with bench retorts) and of oil-gas and water gas plants in the United States, 1898–1915.

yearly increase of only 33 cubic feet, compared with 91 cubic feet annually in the period from 1898 to 1908. The average price of coal gas decreased from 93 cents per thousand in 1908 to 91 cents in 1912, but was 92 cents in 1915. The average price of oil gas and water gas decreased from 93 cents in 1908 to 90 cents in 1915; the rate of decrease in price from 1908 on was, however, almost negligible, compared with the rate of decrease prior to 1908.

The data in figure 35 show the relation of price and consumption through a period of years, the country being considered as a whole. The same relation is evident if the statistics for different localities are examined for any one year. In figure 36 the consumption of coal gas (exclusive of by-product coke-oven gas) and of oil gas and water gas in 1915 in the various States is plotted with respect to the average price of the gas in those States. The loci of the points thus obtained are scattered over the area of the diagram, and in order to construct a curve showing the average trend the totals for all States having prices between 80 and 89 cents, 90 and 99 cents, etc., were averaged. The line connecting these points may then be considered to represent the relation between price and consumption in 1915. The curves

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for both coal gas and water gas show that where the price of gas is highest consumption is least; that the increase in consumption is small when the price exceeds $1 a thousand cubic feet for coal gas and 90 cents and $1 for water gas; that between a price of 80 cents and 90 cents there are abrupt changes in the curves; and that at the lowest prices the consumption of gas is greatest.

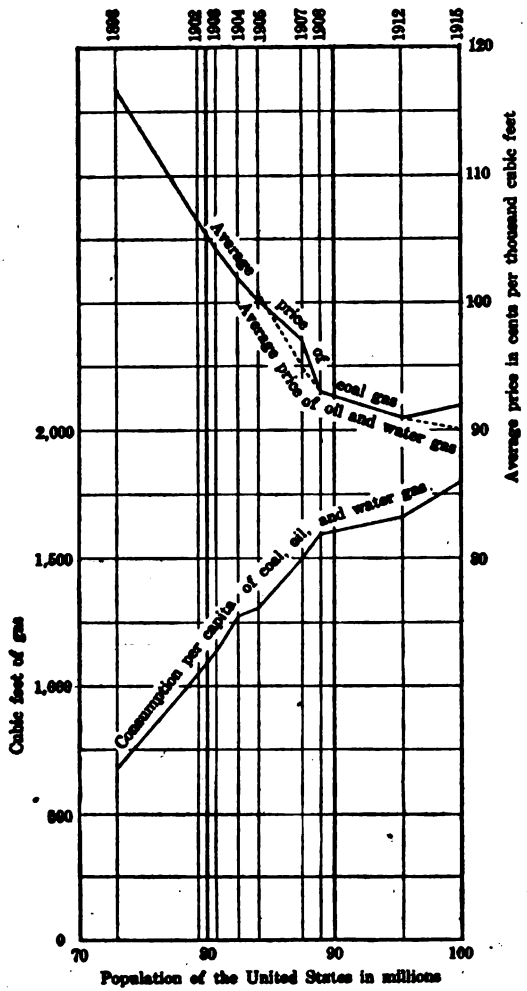

FIGURE 35.—Variation of consumption per capita of artificial gas in the United States according to population and average price of gas, 1898–1915.

The changes in these curves may not warrant general conclusions, but it is significant that the more or less abrupt changes in the curves of consumption in figure 36 occur at approximately the same price level as the change in the curve of consumption per capita in figure 35. Whether the price level is considered as a progressive factor affecting the consumption of gas per capita over a period of years or as a static factor involving the relation of total consumption to average price in different localities at the same time, it is evident from this study that the lowering of price has had a marked influence in increasing consumption and that in the United States under present conditions the minimum average price has already been reached. If this is true, then further increase in consumption per capita will be due to mere aggregation of population. That the use of gas for illumination decreased after the price of gas became more or less stationary is also significant. With prices stationary competition between gas and electricity for illumination has been predicated on service, with the advantage generally in favor of electricity.

In its effect upon the consumption of gas, price is, of course, a relative matter. A decrease in the price of electricity in any locality is equivalent in its effect on the competition between these services for illumination to an increase in the price of gas. It is noteworthy

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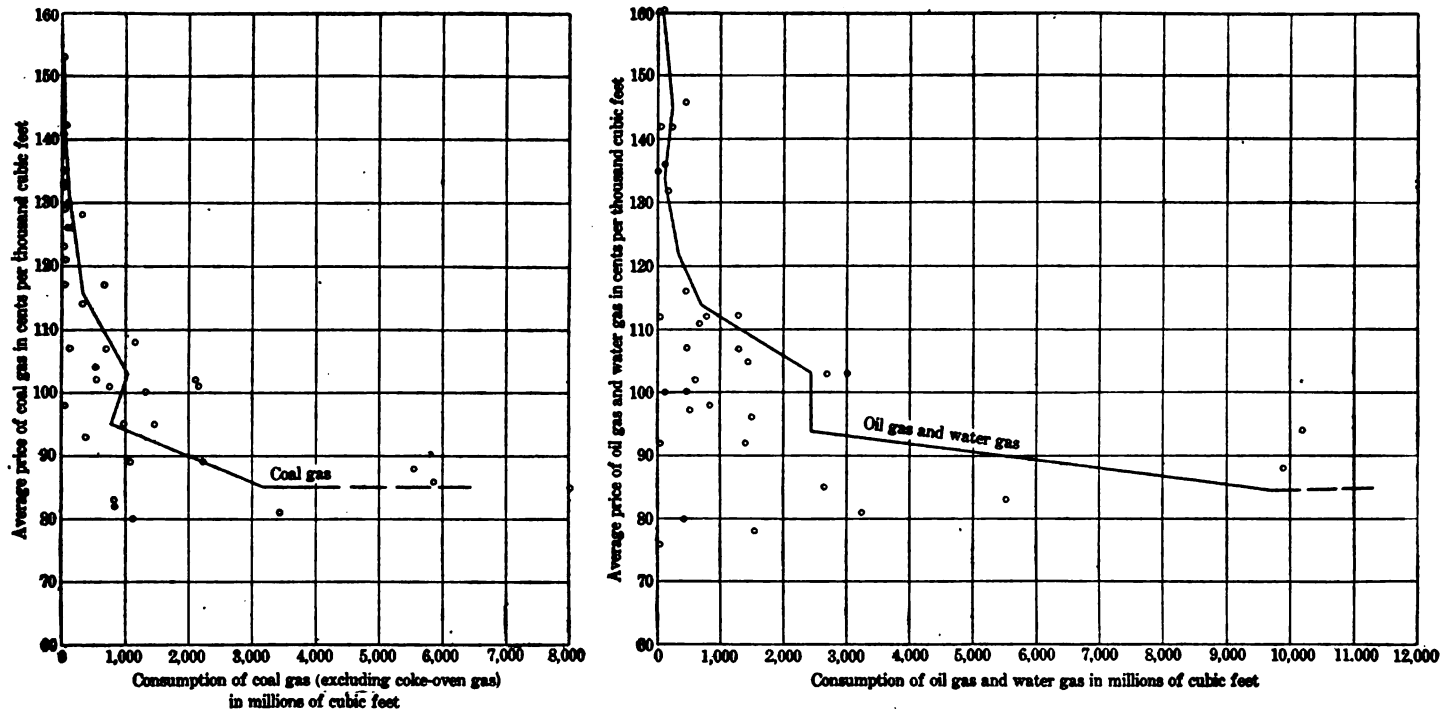

FIGURE 36.—Variation of consumption of artificial gas according to average price in the various States in 1915.

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also that the general upward trend in the price of anthracite, in late years, has not been without effect in increasing the use of gas for domestic fuel in the eastern cities.

The data from which the curves in figures 32 to 35 were drawn are given in the following tables. The statistics of consumption and value of coal gas, oil gas, and water gas, by States, which form the basis of figure 36, will be found on pages 1044–1045 and 1049–1050.

Artificial gas consumed in the United States, 1898–1915, by kinds.

	Sales (M cubic feet).	Value.	Average price (M cubic feet).
1898.			
Coal gas	18,431,201	$21,502,295	$1.17
Water gas	a 30,418,987		
Oil gas	a 497,016		
By-product gas	a 3,620,673		
1902.			
Coal gas	25,069,000	29,312,881	1.01
By-product gas	4,010,074		
1903.			
Coal gas	25,670,000	30,315,776	.98
By-product gas	5,379,462		
1904.			
Coal gas	30,109,449	32,090,998	.92
By-product gas	4,705,542		
1905.			
Coal gas	30,722,279	32,937,456	.81
By-product gas	9,731,936		
Oil gas and water gas	77,412,025	78,072,500	1.01
1907.			
Coal gas	34,302,954	33,331,465	.97
By-product gas	20,516,731	3,130,539	.15
Oil gas and water gas	94,634,620	90,173,112	.95
1908.			
Coal gas	37,355,886	34,670,418	.93
By-product gas	16,205,925	2,557,483	.16
Oil gas and water gas	103,347,497	96,343,221	.93
1912.			
Coal gas	35,202,124	32,031,367	.91
By-product gas	54,491,248	4,650,517	.09
Oil gas and water gas	122,697,796	111,600,841	.91
1915.			
Coal gas	43,747,432	40,257,108	.92
By-product gas	84,355,914	8,624,809	.10
Oil gas and water gas	138,100,902	124,950,125	.90

a Figures of production.

Artificial gas consumed in the United States, 1898–1915, by uses, in thousand cubic feet.

	Illuminating gas.	Fuel gas.	Total.
1898.			
Coal gas	15,955,149	2,476,052	18,431,201
1902.			
Coal and by-product gas	23,401,319	5,677,755	29,079,074
1903.			
Coal and by-product gas	22,953,792	8,095,669	31,049,461
1904.			
Coal and by- product gas	25,864,097	8,950,894	34,814,991
1905.			
Coal and by-product gas	26,817,836	13,636,379	40,454,215
Oil gas and water gas	59,531,805	17,880,220	77,412,025
	86,349,641	31,516,599	117,866,240

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Artificial gas consumed in the United States, 1898–1915, by uses, in thousand cubic feet— Continued.

	Illuminating gas.	Fuel gas.	Total.
1907.			
Coal and by-product gas	30,156,774	24,662,913	54,819,687
Oil gas and water gas	71,931,612	22,703,008	94,634,620
	102,088,386	47,365,921	149,454,307
1908.			
Coal and by-product gas	32,485,571	21,076,242	53,561,813
Oil gas and water gas	76,804,546	26,542,951	103,347,497
	109,290,117	47,619,193	156,909,310
1912.			
Coal and by-product gas	31,864,052	57,829,320	89,693,372
Oil gas and water gas	68,136,269	54,561,527	122,697,796
	100,000,321	112,390,847	212,391,168
1915.			
Coal and by-product gas	31,541,485	96,561,861	128,103,346
Oil gas and water gas	49,255,388	88,845,514	138,100,902
	80,796,873	185,407,375	266,204,248

Average capacity of artificial gas plants in the United States, 1898–1915.

	Sales.	Plants.	Sales per plant.
	Thousand cubic feet.		*Thousand cubic feet.*
1898: Coal gas	18,431,201	433	42,566
1902: Coal gas	26,069,080	522	48,024
1903: Coal gas	25,670,000	514	49,942
1904: Coal gas	30,109,449	514	58,579
1905:			
Coal gas	30,722,279	508	60,477
Oil gas and water gas	77,412,025	477	162,289
1907:			
Coal gas	34,302,954	493	69,580
Oil gas and water gas	94,634,603	520	181,990
1908:			
Coal gas	37,355,886	482	77,502
Oil gas and water gas	103,347,497	552	187,224
1912:			
Coal gas	35,202,124	424	83,024
Oil gas and water gas	122,697,796	604	203,142
1915:			
Coal gas	43,747,432	396	110,473
Oil gas and water gas	138,100,902	646	213,778

Artificial gas consumed per capita in the United States, 1898–1915.

Year.	Consumption.	Population.	Per capita consumption.
	Thousand cubic feet.		*Cubic feet.*
1898	49,347,204	72,947,000	676
1902	83,000,000	79,220,563	1,048
1903	91,000,000	80,848,557	1,126
1904	105,000,000	82,466,551	1,273
1905	108,134,304	84,084,545	1,286
1907	128,937,574	87,320,539	1,477
1908	140,703,383	88,938,527	1,582
1912	157,899,920	95,410,503	1,655
1915	181,848,334	100,536,347	1,809

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PRODUCTION OF GAS.

The artificial gas (oil gas, water gas, and coal gas from retorts and from by-product coke ovens) marketed and sold in 1915 amounted to 266,204,248,000 cubic feet, valued at $173,832,132, an increase of 25 per cent in quantity and 17 per cent in value, compared with 1912, the next preceding year for which the statistics of this industry were collected by the United States Geological Survey.

The quantity of gas from coal-gas plants in 1915 was 43,747,432,000 cubic feet, valued at $40,257,108, an increase of 24 per cent in quantity and 26 per cent in value, compared with 1912. The quantity of surplus gas sold or used from by-product coke ovens in 1915 was 84,355,914,000 cubic feet, valued at $8,624,899, an increase of 55 per cent in quantity and 85 per cent in value. The average price of the coal gas in 1915 was 92 cents per 1,000 cubic feet and that of gas from by-product coke ovens was 10 cents, the difference being due to the fact that the price of coal gas includes the cost of distribution to domestic consumers, whereas the price of coke-oven gas is reported at the place of production. The aggregate output of coal gas in 1915 was 128,103,346,000 cubic feet, valued at $48,882,007, an increase, compared with 1912, of 43 per cent in quantity and 33 per cent in value.

Water gas enriched with oil (carbureted water gas) is more generally used in cities than coal gas. The quantity of water gas manufactured and sold in 1915 was 124,129,569,000 cubic feet—nearly as much as the combined output of coal gas from retorts and from coke ovens—and was about 47 per cent of the total quantity of artificial gas sold.

In California, Arizona, and Oregon nearly all the artificial gas produced is made from oil, and in other States also there are oil-gas plants. The quantity of oil gas manufactured and sold in the United States in 1915 was 13,971,333,000 cubic feet. The aggregate of oil gas and water gas sold in 1915 was 138,100,902,000 cubic feet, valued at $124,950,125, an increase, compared with 1912, of 13 per cent in quantity and 12 per cent in value. The average price of oil gas and water gas in 1915 was 90 cents per 1,000 cubic feet, compared with 92 cents for coal gas from retorts.

The schedules sent to producers for reports of their operations in 1915 requested a division of sales that would show the gas used for illumination, for domestic fuel, and for industrial fuel. About half the companies were able to make this separation and some of the others furnished estimates. For those companies which reported no separation, estimates were made in the Geological Survey, with due consideration of the statistics reported by other companies similarly situated, of the published data regarding population served and street lamps supplied, and of other pertinent information.

The difficulty in obtaining information concerning sales by use is due to the fact that in many cities gas for different uses is not metered separately, that going to households, in particular, being used for both lighting and cooking and being measured in the same meter and sold for the same price. The accuracy of the compilation is dependent, of course, on that of the original sources and, in view of the conditions existing, the division of sales according to different uses given in this and previous reports must be considered as best available estimates, and not as of the accuracy of the total sales and production.

The statistics collected by the Geological Survey for 1912 showed that 47 per cent of the artificial gas sold was used for illumination;

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the statistics for 1915 show that 30 per cent of the gas sold was used for illumination, 48 per cent for domestic fuel, and 22 per cent for industrial fuel.

Artificial gas consumed in the United States in 1915.

Kind.	Illuminating gas.		Domestic fuel.	
	Quantity (M cubic feet).	Value.	Quantity (M cubic feet).	Value.
Coal gas	14,345,059	$13,275,510	24,204,443	$22,754,095
Water gas	47,816,398	43,087,060	65,920,911	60,096,205
Oil gas	1,438,999	1,261,936	12,173,252	11,073,530
By-product gas	17,196,426	3,083,311	27,590,624	3,158,129
	80,796,873	60,707,817	129,889,230	97,081,959

Kind.	Industrial fuel.		Total.	
	Quantity (M cubic feet).	Value.	Quantity (M cubic feet).	Value.
Coal gas	5,197,930	$4,227,503	43,747,432	$40,257,108
Water gas	10,392,260	9,098,691	124,129,569	112,281,956
Oil gas	359,091	332,703	13,971,333	12,668,169
By-product gas	39,568,864	2,383,459	84,355,914	8,624,899
	55,518,145	16,042,356	266,204,248	173,832,132

COAL GAS.

In the following tables the production and sales of coal gas in 1912 and 1915 by uses and by States are given, together with the totals for gas from by-product coke ovens. In previous reports the statistics of coal gas and of by-product gas have been combined; in the present report they are shown separately in order to afford comparable figures of average prices of gas. The price of gas reported to the Geological Survey by the operators of coal-gas plants is the cost to the ultimate consumer and includes the cost of distribution. The price of gas reported by the operators of by-product ovens is the price at the place of production and does not represent cost of gas after distribution to domestic consumers. For example, a by-product plant will be operated by one company and will sell its gas for distribution to another company under common ownership. The price of the gas for the producing company (which may be less than 10 cents a thousand) is the cost to the distributing company; the price of the gas for the distributing company is the cost to the individual consumer and may be 80 cents or more per thousand cubic feet. The large difference in average price, 10 cents per thousand cubic feet for by-product coke-oven gas against 92 cents for retort coal gas, is almost entirely due to different methods of reporting and in but small measure to difference in cost of production.

The quantity of coal gas produced in 1915 from the old-style retorts was 47,638,905,000 cubic feet, of which 43,747,432,000 cubic feet, or 92 per cent, was marketed, and 3,891,473,000 cubic feet, or 8 per cent, was lost or otherwise unaccounted for. More than 14,345,000,000 cubic feet, or 33 per cent, was sold for illumination at an average price of 93 cents per thousand; 24,204,000,000 cubic feet, or 55 per cent, was sold for domestic fuel at an average price of 94 cents a thousand; and 5,198,000,000 cubic feet, or 12 per cent, was sold for industrial fuel at an average price of 81 cents a thousand.

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Coal gas produced and consumed in the United States in 1912.

State.	Number of plants.	Gas produced (M cubic feet).	Sold for illumination.			Sold for fuel.			Total gas sold.			Gas unaccounted for (M cubic feet).
			Quantity (M cubic feet.)	Value.	Price per M cubic feet.	Quantity (M cubic feet).	Value.	Price per M cubic feet.	Quantity (M cubic feet).	Value.	Price per M cubic feet.	
Alabama	11	652,263	215,128	$238,093	$1.11	386,179	$409,076	$1.06	601,307	$647,169	$1.08	50,956
Arkansas	1											
California	1											
Oregon	3	29,705	12,001	23,546	1.96	12,605	24,251	1.92	24,606	47,797	1.94	5,099
Colorado	7	1,064,826	115,217	123,698	1.07	866,927	807,747	.93	982,144	931,445	.95	82,682
Connecticut	8	1,614,113	887,315	841,212	.95	620,291	576,091	.93	1,507,606	1,417,303	.94	106,507
Rhode Island	2											
Delaware	3	189,347	56,272	50,593	.90	110,543	98,584	.89	166,815	149,177	.89	22,532
District of Columbia	2											
Florida	2											
Louisiana	1	145,836	26,960	39,147	1.45	96,612	129,618	1.17	123,572	168,765	1.37	22,264
Mississippi	6											
Georgia	10	547,707	207,786	228,631	1.10	267,600	299,947	1.10	475,386	528,578	1.10	72,321
Idaho	3											
Montana	4											
North Dakota	2	323,148	78,187	115,151	1.43	212,243	321,588	1.52	290,430	436,739	1.50	32,718
South Dakota	1											
Wyoming	1											
Illinois	35	2,466,107	1,091,468	1,102,525	1.01	1,140,540	1,163,164	1.02	2,232,008	2,265,689	1.02	234,099
Indiana	28	1,660,085	629,297	558,568	.89	887,613	788,541	.89	1,516,910	1,347,109	.89	143,175
Iowa	15	781,462	308,110	333,038	1.08	393,782	400,801	1.02	701,892	733,839	1.05	79,570
Kansas	1											
Nebraska	1	64,476	16,100	23,990	1.49	41,474	56,949	1.37	57,574	80,939	1.41	6,902
Oklahoma	1											
Kentucky	10	870,851	193,224	199,836	1.03	611,492	440,008	.72	804,716	639,844	.80	66,135
Maine	7	263,082	129,607	165,021	1.27	112,205	125,385	1.12	241,812	290,406	1.20	21,270
Maryland	7	74,719	37,813	52,010	1.38	35,129	49,304	1.40	72,942	101,314	1.39	1,777
Massachusetts	34	4,133,079	1,990,325	1,829,235	.92	1,905,381	1,690,586	.89	3,895,706	3,519,821	.90	237,373
Michigan	48	4,691,702	1,697,592	1,561,555	.92	2,540,642	2,240,859	.88	4,238,234	3,802,414	.90	453,468
Minnesota	9	1,207,941	411,105	410,276	1.00	694,196	685,371	.99	1,105,301	1,095,647	.99	102,640
Missouri	11	1,732,842	558,763	474,416	.85	1,047,545	855,949	.82	1,606,308	1,330,365	.83	126,534
New Hampshire	5	272,523	142,825	179,472	1.26	113,594	138,697	1.22	256,419	318,169	1.24	16,104
Vermont	2											
New Jersey	9	905,384	421,204	431,900	1.03	424,325	438,382	1.03	845,529	870,282	1.03	59,855
New Mexico	1	346,500	30,092	37,750	1.25	293,873	256,711	.87	323,965	294,461	.91	22,535
Utah	2											
New York	39	8,078,742	3,141,865	2,382,965	.76	4,356,748	2,763,748	.63	7,498,613	5,146,713	.69	580,129
North Carolina	6	150,347	58,084	81,327	1.40	70,866	126,479	1.59	*128,950	207,806	1.61	21,397
South Carolina	1											

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Ohio	15	655,168	390,925	358,658	.92	191,717	159,961	.83	582,653	518,619	.89	72,516
Pennsylvania	16	1,963,211	1,273,636	1,296,971	1.01	153,390	156,844	1.02	1,432,025	1,453,815	1.02	521,196
Tennessee	6	667,403	299,910	306,470	1.03	299,322	304,113	1.02	598,232	610,683	1.02	99,171
Texas	4	90,220	3,697	4,806	1.30	70,602	100,232	1.42	74,349	106,038	1.41	15,871
Virginia	13	833,281	406,492	418,488	1.03	295,402	316,163	1.07	701,894	734,651	1.05	131,387
West Virginia	2											
Washington	9	980,224	384,122	450,369	1.17	522,712	633,385	1.21	906,834	1,068,754	1.22	73,380
Wisconsin	20	1,431,459	430,763	411,637	.96	776,680	741,479	.95	1,207,393	1,153,116	.96	224,066
	425	38,877,783	15,649,905	14,731,354	.94	19,552,229	17,300,013	.88	35,202,124	32,031,867	.91	3,675,629
By-product coke-oven gas	33		16,214,157	2,868,302	.18	38,277,091	1,782,215	.05	54,491,248	4,660,517	.09	
Grand total	458		31,864,062	17,599,656	.55	57,829,320	19,082,228	.33	89,693,372	36,691,884	.41	

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Coal gas produced and consumed in the United States in 1915.

State.	Number of plants.	Total gas produced (M cubic feet).	Sold for illumination.			Sold for domestic fuel.			Sold for industrial fuel.			Total gas sold.			Gas unaccounted for.	
			Quantity (M cubic feet).	Value.	Average price.	Quantity (M cubic feet).	Value.	Average price.	Quantity (M cubic feet).	Value.	Average price.	Quantity (M cubic feet).	Value.	Average price.	Quantity (M cubic feet).	Percentage of loss.
Alabama	11	920,282	160,986	$174,185	$1.08	494,242	$528,806	$1.07	45,322	$44,596	$0.98	700,550	$747,587	$1.07	219,732	23.9
California, New Mexico and Wyoming	3	40,966	4,477	5,841	1.30	26,230	37,953	1.45	2,864	3,857	1.35	33,571	47,651	1.42	7,395	18.1
Colorado	6	1,241,028	183,111	151,818	.83	590,838	495,778	.84	340,771	249,704	.73	1,114,720	897,300	.80	126,308	10.2
Connecticut	9	1,544,694	591,404	564,588	.95	669,382	638,607	.95	209,168	200,361	.96	1,469,954	1,403,556	.95	74,740	4.8
Delaware, Florida, South Carolina, Vermont, and West Virginia	8	369,764	92,202	110,867	1.20	226,092	274,505	1.21	8,424	10,603	1.26	326,718	395,975	1.21	43,046	11.6
District of Columbia and Maryland	7	383,678	79,118	78,541	.99	230,641	225,056	.98	11,460	10,583	.92	321,228	314,180	.98	62,450	16.3
Georgia	10	731,058	177,659	204,285	1.15	493,479	579,181	1.17	12,139	15,724	1.30	683,277	799,190	1.17	47,781	6.5
Idaho	3	78,702	6,583	10,826	1.64	63,578	106,888	1.74	3,000	4,350	1.45	73,161	122,064	1.53	5,541	7.0
Illinois	36	2,363,304	1,043,627	1,033,350	.99	952,395	982,468	1.03	166,598	162,013	.97	2,162,620	2,177,831	1.01	200,684	8.5
Indiana	26	1,459,512	331,791	330,744	1.00	944,396	944,363	1.00	39,658	37,004	.93	1,315,835	1,312,111	1.00	143,677	9.8
Iowa	12	601,700	135,952	143,146	1.06	374,962	395,078	1.05	34,879	28,913	.83	545,793	567,137	1.04	55,907	9.3
Kansas, North Dakota, and South Dakota	6	196,130	15,637	21,395	1.37	156,504	211,864	1.35	1,473	2,002	1.36	173,614	235,261	1.36	22,516	11.5
Kentucky	9	136,780	21,108	22,840	1.08	93,153	99,772	1.07	.....	.....	.....	114,261	122,612	1.07	22,519	16.5
Louisiana and Texas	3	130,423	11,188	14,432	1.29	91,809	119,575	1.30	9,738	12,263	1.26	112,735	146,270	1.30	17,688	13.6
Maine	6	360,736	162,447	191,881	1.18	129,988	144,898	1.11	22,677	22,935	1.01	315,092	359,714	1.14	45,644	12.7
Massachusetts	32	5,841,499	2,049,474	1,802,743	.88	2,843,608	2,507,570	.88	634,712	537,572	.85	5,527,794	4,847,885	.88	313,705	5.4
Michigan	50	6,371,003	1,532,836	1,378,236	.90	3,447,546	3,095,315	.90	881,660	560,167	.64	5,862,042	5,033,718	.86	508,961	8.0
Minnesota	7	878,077	305,147	254,163	.83	415,967	349,046	.84	103,107	84,283	.82	824,221	687,492	.83	53,856	6.1
Mississippi	6	126,108	23,434	30,557	1.30	64,143	82,831	1.29	15,562	16,795	1.08	103,139	130,183	1.26	22,969	18.2
Missouri	9	3,438,166	985,924	800,264	.81	1,630,869	1,318,928	.81	682,489	502,767	.79	3,249,282	2,621,959	.81	188,884	5.5
Montana	3	102,306	3,165	5,539	1.75	59,778	96,673	1.62	22,509	34,462	1.53	85,452	136,674	1.33	16,854	16.5
New Hampshire	4	139,291	62,156	77,537	1.25	51,339	65,700	1.28	12,160	15,821	1.20	126,655	159,058	1.26	12,636	9.1
New Jersey	7	1,044,634	387,902	367,190	.95	528,144	501,770	.95	47,199	43,646	.92	963,245	912,606	.95	81,389	7.8
New York	34	8,347,116	3,225,831	2,763,920	.86	4,138,749	3,522,279	.85	670,660	552,807	.82	8,035,240	6,839,006	.85	311,876	3.7
North Carolina	9	399,401	51,475	66,396	1.29	293,729	375,389	1.28	503	664	1.32	345,707	442,449	1.28	53,694	13.4
Ohio	10	923,374	286,311	273,774	.96	306,484	272,356	.89	227,788	124,600	.55	820,583	670,730	.82	102,791	11.1

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Oklahoma	3	55,438	4,920	5,394	1.10	41,832	49,446	1.18	1,694	1,721	1.02	48,446	56,561	1.17	6,922	12.6
Oregon	3	33,260	4,149	7,252	1.76	25,175	42,987	1.71	197	310	1.57	29,521	50,579	1.71	3,739	11.2
Pennsylvania	13	2,588,615	928,116	944,758	1.02	969,084	1,005,329	1.02	188,890	189,723	1.00	2,106,090	2,139,810	1.02	482,525	18.6
Rhode Island	3	1,139,513	319,681	286,857	.90	639,144	562,473	.99	119,615	105,488	.88	1,068,440	954,818	.89	71,073	6.2
Tennessee	6	651,249	224,885	229,795	1.02	275,853	287,040	1.03	56,651	58,503	.96	503,490	576,338	1.02	87,760	13.5
Utah	3	477,853	15,437	15,088	.98	389,069	341,674	.93	10,918	9,734	.89	395,464	366,806	.93	82,399	17.2
Virginia	11	870,716	229,209	229,861	1.00	430,528	433,923	1.01	100,106	101,540	1.01	759,943	765,444	1.01	110,973	12.7
Washington	9	1,256,320	146,721	160,834	1.16	749,389	823,697	1.10	259,065	288,972	1.00	1,155,195	1,252,603	1.08	104,125	8.3
Wisconsin	19	2,383,209	540,996	507,353	.94	1,373,224	1,234,877	.90	200,245	223,020	.74	2,214,465	1,965,250	.89	178,744	7.6
	396	47,638,905	14,345,059	13,275,510	.93	24,204,443	22,754,096	.94	5,197,920	4,227,503	.81	43,747,432	40,257,108	.92	3,891,473	8.2
By-product coke-oven gas	39	.....	17,196,426	3,063,311	.18	27,590,624	3,168,129	.11	39,568,864	2,383,459	.06	84,355,914	8,624,890	.10	.....	.....
Grand total	435	.....	31,541,485	16,338,821	.52	51,795,067	25,912,224	.50	44,766,794	6,610,962	.15	128,103,346	48,882,007	.38	.....	.....

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OIL GAS AND WATER GAS.

The production of oil gas and water gas in 1915 was 152,368,423,000 cubic feet, and the quantity sold was 138,100,902,000 cubic feet, valued at $124,950,125, an increase, compared with 1912, of 15,403,116,000 cubic feet, or 13 per cent, in quantity and of $13,349,284, or 12 per cent, in value. Gas lost and unaccounted for was 14,267,521,000 cubic feet, or 9 per cent of the production. The quantity of oil gas and water gas used for illuminating in 1915 was 49,255,388,000 cubic feet, or 36 per cent of the total sales of these kinds of gas; that used for domestic fuel was 78,094,163,000 cubic feet, or 57 per cent; and that used for industrial fuel was 10,751,351,000 cubic feet, or 7 per cent, of the total.

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Oil gas and water gas produced and consumed in the United States in 1912.

State.	Number of establishments.	Total gas produced (M cubic feet).	Sold for illumination.			Sold for fuel.			Total gas sold.			Gas unaccounted for (M cubic feet).
			Quantity (M cubic feet).	Value.	Price per M cubic feet.	Quantity (M cubic feet).	Value.	Price per M cubic feet.	Quantity (M cubic feet).	Value.	Price per M cubic feet.	
Alabama	4	134,250	46,412	$47,368	$1.02	85,696	$86,685	$1.01	132,108	$134,053	$1.01	2,142
Arizona	6	118,376	18,314	32,057	1.75	80,457	127,910	1.40	98,771	159,967	1.62	19,605
California	62	14,636,735	3,992,826	3,410,152	.85	8,985,076	7,781,684	.86	12,977,902	11,191,836	.86	1,658,833
Colorado	5	308,031	34,348	37,290	1.09	251,538	222,867	.89	285,886	260,157	.91	22,145
Connecticut	21	3,270,990	1,694,265	1,731,569	1.02	1,344,363	1,245,917	.93	3,038,568	2,977,486	.98	232,422
Delaware	3	473,429	253,769	244,015	.96	165,484	158,519	.96	419,253	402,534	.96	54,176
District of Columbia	2	5,525,790	2,123,962	1,869,604	.88	2,987,444	2,601,984	.87	5,111,406	4,471,588	.87	414,384
Maryland	6											
Florida	10	560,344	184,163	243,281	1.32	288,953	361,945	1.25	473,116	605,226	1.28	87,228
Georgia	4	926,281	386,046	385,264	1.00	475,889	459,446	.97	861,935	844,710	.98	64,346
Illinois	35	2,558,672	1,051,442	1,072,464	1.02	1,314,746	1,345,945	1.02	2,366,188	2,418,409	1.02	192,484
Indiana	19	2,508,894	857,970	728,221	.85	1,415,459	1,153,754	.82	2,273,429	1,881,975	.83	235,465
Iowa	43	2,058,107	1,046,109	1,092,454	1.04	886,382	950,778	1.07	1,932,551	2,043,232	1.06	125,556
Kansas	1											
Oklahoma	2	1,309,360	444,399	530,106	1.19	803,932	957,702	1.19	1,248,331	1,487,808	1.19	61,029
Nebraska	15											
Kentucky	5	947,031	459,614	469,422	1.02	450,930	357,884	.79	910,444	827,306	.91	36,587
Tennessee	4											
Louisiana	2	1,143,558	416,364	437,048	1.05	625,309	657,008	1.05	1,041,673	1,094,056	1.05	101,885
Mississippi	2											
Maine	3	211,584	60,399	72,753	1.20	125,643	147,660	1.18	186,042	220,413	1.18	25,542
Massachusetts	38	10,923,242	8,188,654	7,673,139	.94	2,281,947	2,064,770	.90	10,470,601	9,737,909	.93	452,641
Michigan	21	2,224,141	679,070	548,126	.81	1,251,776	979,534	.78	1,930,846	1,527,660	.79	293,295
Minnesota	10	2,778,783	976,828	903,365	.93	1,554,035	1,220,548	.78	2,529,863	2,124,413	.84	248,920
Missouri	13	4,322,174	1,339,326	1,091,591	.82	2,650,667	2,159,736	.81	3,989,993	3,251,327	.81	332,181
Montana	2	34,902	10,408	16,253	1.56	21,473	33,701	1.57	31,881	49,954	1.57	3,021
North Dakota	3											
Nevada	3											
New Mexico	1	65,398	9,295	16,580	1.78	46,699	71,151	1.52	55,994	87,731	1.57	9,404
Utah	1											
New Hampshire	8	339,571	186,285	235,327	1.26	124,394	149,790	1.20	310,679	385,117	1.24	28,892
New Jersey	22	10,150,608	4,392,788	4,476,347	1.02	4,475,305	4,616,085	1.03	8,868,093	9,092,432	1.03	1,282,515
New York	64	45,907,509	25,216,308	21,396,939	.85	16,276,007	12,973,535	.80	41,492,315	34,370,474	.83	4,315,194
North Carolina	8	528,338	193,736	252,633	1.27	279,628	351,048	1.26	473,364	603,681	1.26	49,974
South Carolina	4											
Ohio	10	1,213,016	452,879	403,285	.89	669,952	544,439	.81	1,122,831	947,724	.84	90,185
Oregon	4	1,499,660	520,405	483,275	.93	782,011	727,547	.93	1,302,416	1,210,822	.93	197,244
Pennsylvania	62	13,009,863	10,687,074	10,772,549	1.01	1,393,677	1,412,379	1.01	12,080,751	12,184,928	1.01	929,112

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Oil gas and water gas produced and consumed in the United States in 1912—Continued.

State.	Number of establishments.	Total gas produced (M cubic feet).	Sold for illumination.			Sold for fuel.			Total gas sold.			Gas unaccounted for (M cubic feet).
			Quantity (M cubic feet).	Value.	Price per M cubic feet.	Quantity (M cubic feet).	Value.	Price per M cubic feet.	Quantity (M cubic feet).	Value.	Price per M cubic feet.	
Rhode Island	5	1,440,437	751,906	$708,560	$0.94	632,803	$594,056	$0.94	1,384,709	$1,302,616	$0.94	55,728
South Dakota	10	197,114	79,035	113,567	1.44	102,479	151,271	1.48	181,514	264,838	1.46	15,600
Texas	16	1,149,840	303,559	361,049	1.19	717,246	870,874	1.21	1,020,805	1,231,923	1.20	129,035
Vermont	8	175,688	55,143	71,888	1.30	97,438	130,890	1.34	152,581	202,778	1.32	23,107
Virginia	11	1,000,285	610,806	568,176	.93	260,602	281,516	1.08	871,408	849,692	.98	128,877
West Virginia	3											
Washington	5	678,204	298,936	310,024	1.04	326,785	342,077	1.05	625,721	652,101	1.04	52,483
Wisconsin	18	477,304	109,426	125,355	1.15	329,402	376,610	1.14	438,828	501,965	1.14	38,476
	604	134,707,509	68,136,269	62,931,596	.924	54,561,527	48,669,245	.89	122,697,796	111,600,941	.91	12,009,713

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Oil gas and water gas produced and consumed in the United States in 1915.

State.	Number of plants.	Total gas produced (M cubic feet).	Sold for illumination.			Sold for domestic fuel.			Sold for industrial fuel.			Total gas sold.			Gas unaccounted for.	
			Quantity (M cubic feet).	Value.	Average price per M cubic feet.	Quantity (M cubic feet).	Value.	Average price per M cubic feet.	Quantity (M cubic feet).	Value.	Average price per M cubic feet.	Quantity (M cubic feet).	Value.	Average price per M cubic feet.	Quantity (M cubic feet).	Percentage of loss.
Alabama	3	174,628	35,554	$35,606	$1.00	73,220	$73,606	$1.01	9,628	$9,599	$1.00	118,402	$118,811	$1.00	56,426	32.3
Arizona	7	165,140	150	282	1.88	152,398	245,528	1.61	4,452	7,175	1.61	157,000	252,985	1.61	8,140	4.9
Arkansas, Kentucky, Louisiana, and Mississippi	6	1,399,050	143,506	158,754	1.11	790,669	847,777	1.07	355,467	375,501	1.06	1,289,642	1,382,032	1.07	109,408	.8
California	64	14,789,449	1,262,665	1,074,585	.85	11,234,761	10,012,854	.89	355,130	313,932	.88	12,852,556	11,401,371	.89	1,936,893	13.1
Colorado	6	484,223	68,043	55,884	.82	259,489	219,359	.85	119,964	82,408	.69	446,496	357,651	.80	37,727	7.8
Connecticut	21	3,240,772	1,276,681	1,315,584	1.03	1,349,165	1,379,139	1.02	406,969	416,129	1.02	3,032,815	3,110,852	1.03	207,957	6.4
Delaware	5	571,554	246,742	236,407	.96	261,703	255,649	.98	.....	.....	.....	508,445	492,056	.97	63,109	11.0
District of Columbia and Maryland	9	5,878,366	1,338,697	1,116,810	.83	4,022,321	3,357,935	.83	136,645	110,222	.81	5,497,663	4,584,967	.83	380,703	6.5
Florida	13	539,428	157,928	227,644	1.44	345,593	507,197	1.47	1,075	1,864	1.73	504,596	736,705	1.46	34,832	6.5
Georgia	6	850,861	291,823	332,627	1.14	490,473	545,127	1.11	14,194	15,178	1.07	796,490	892,932	1.12	54,371	6.4
Illinois	41	21,416,716	9,528,847	8,047,922	.84	9,071,620	7,701,491	.85	1,367,636	1,144,682	.84	19,968,103	16,894,095	.85	1,448,613	6.8
Indiana	16	1,697,775	369,066	355,320	.96	1,132,676	1,086,149	.96	49,679	44,502	.90	1,551,421	1,485,971	.96	146,354	8.6
Iowa	50	2,864,696	678,864	697,054	1.03	1,895,984	1,955,522	1.03	124,604	125,881	1.01	2,699,452	2,778,457	1.03	165,244	5.8
Kansas	5	56,190	4,571	6,110	1.34	42,192	57,326	1.36	1,790	2,348	1.31	48,553	65,784	1.35	7,637	13.6
Maine	4	231,543	103,124	120,656	1.17	99,356	117,642	1.18	5,274	5,274	1.00	207,754	243,572	1.17	23,789	10.3
Massachusetts	36	8,291,306	2,739,474	2,385,301	.87	4,212,097	3,711,692	.88	958,408	831,082	.87	7,909,979	6,928,075	.88	381,327	4.6
Michigan	18	1,692,973	373,215	313,849	.84	799,371	666,830	.83	389,854	233,699	.60	1,562,440	1,214,378	.78	130,533	7.7
Minnesota	11	3,552,794	1,277,570	1,035,230	.81	1,617,188	1,322,915	.82	446,052	360,376	.81	3,340,810	2,718,521	.81	211,984	6.0
Missouri	15	2,818,488	800,795	693,280	.85	1,379,393	1,189,571	.86	458,003	367,804	.80	2,638,191	2,240,655	.85	180,297	6.4
Montana	3	70,542	9,117	13,667	1.50	44,496	63,154	1.42	12,374	17,137	1.38	65,987	93,958	1.42	4,555	6.5
Nebraska	18	1,358,010	355,792	389,321	1.09	791,322	896,943	1.13	144,611	157,988	1.09	1,291,725	1,444,252	1.12	66,285	4.9
Nevada	3	49,363	4,789	9,959	2.08	33,628	69,869	2.08	4,799	9,959	2.08	43,201	89,787	2.08	6,162	12.5
New Hampshire	9	523,852	233,036	272,319	1.17	178,558	211,902	1.19	56,567	60,964	1.08	468,161	545,185	1.16	55,691	10.6
New Jersey	26	11,970,196	4,074,978	3,850,013	.94	5,770,453	5,359,912	.93	372,900	345,410	.93	10,218,331	9,555,335	.94	1,751,865	14.6
New Mexico, Oklahoma, and Utah	4	74,793	1,198	1,584	1.32	62,655	69,638	1.11	600	940	1.57	64,453	72,162	1.12	10,340	1.4
New York	63	46,939,337	17,501,007	15,015,077	.86	21,664,415	18,443,212	.85	3,377,135	2,828,650	.84	42,542,557	36,296,939	.85	4,396,780	9.4

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Oil gas and water gas produced and consumed in the United States in 1915—Continued.

State.	Number of plants.	Total gas produced (M cubic feet).	Sold for illumination.			Sold for domestic fuel.			Sold for industrial fuel.			Total gas sold.			Gas unaccounted for.	
			Quantity (M cubic feet).	Value.	Average price per M cubic feet.	Quantity (M cubic feet).	Value.	Average price per M cubic feet.	Quantity (M cubic feet).	Value.	Average price per M cubic feet.	Quantity (M cubic feet).	Value.	Average price per M cubic feet.	Quantity (M cubic feet).	Percentage of loss.
North Carolina.	11	134,099	16,531	$23,292	$1.41	96,257	$130,411	$1.35	555	$703	$1.27	113,343	$154,406	$1.36	20,756	15.5
North Dakota..	3	25,406	5,225	8,309	1.59	19,023	30,543	1.61	1,000	1,500	1.50	25,248	40,352	1.60	158	.6
Ohio.....	8	316,167	76,950	73,774	.96	144,763	106,194	.75	58,305	30,875	.53	280,018	212,843	.76	36,149	11.4
Oregon.....	7	1,617,335	166,901	152,859	.92	1,214,567	1,115,039	.92	13,753	12,426	.90	1,395,221	1,280,324	.92	222,114	13.7
Pennsylvania..	70	12,648,668	4,983,869	5,068,631	1.03	5,263,138	5,406,331	1.03	969,349	994,176	1.00	11,186,356	11,469,138	1.03	1,462,312	11.6
Rhode Island..	4	525,433	145,446	158,273	1.09	287,233	312,320	1.09	53,423	49,706	.93	486,102	520,299	1.07	39,331	7.5
South Carolina.	7	386,195	25,910	31,606	1.22	308,860	376,432	1.22	13,955	16,349	1.17	348,735	424,389	1.22	37,460	9.7
South Dakota..	8	224,880	44,675	62,762	1.40	158,654	225,803	1.42	4,424	6,384	1.44	207,753	294,949	1.42	17,127	7.6
Tennessee.....	3	504,405	186,416	186,416	1.00	232,977	232,977	1.00	46,563	46,563	1.00	465,956	465,956	1.00	38,449	7.6
Texas.....	19	1,618,183	217,206	245,582	1.13	1,158,627	1,348,182	1.16	58,216	59,608	1.02	1,434,109	1,653,372	1.15	184,074	11.4
Vermont.....	7	181,280	37,733	50,142	1.33	104,870	140,260	1.34	21,938	26,818	1.22	164,541	217,220	1.32	16,739	9.2
Virginia.....	10	974,904	270,666	266,183	.98	466,633	457,483	.98	102,709	99,213	.97	842,008	822,879	.98	132,896	13.6
Washington....	5	662,133	68,337	69,752	1.20	393,080	405,699	1.03	137,996	136,265	.99	599,413	611,716	1.02	62,720	9.5
West Virginia..	3	100,191	23,252	23,217	1.00	47,189	41,933	.89	.....	.....	.....	70,441	65,155	.92	29,750	30.0
Wisconsin.....	19	746,899	158,979	177,351	1.12	421,101	470,184	1.12	76,355	82,104	1.08	656,435	729,639	1.11	90,464	12.1
	646	152,368,423	49,255,388	44,348,996	.90	78,094,163	71,169,735	.91	10,751,351	9,431,394	.88	138,100,902	124,950,125	.90	14,267,521	9.4

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FUELS USED IN THE MANUFACTURE OF ARTIFICIAL GAS.

In 1915 more than 47,600,000,000 cubic feet of coal gas was produced from 4,645,000 net tons of bituminous coal, 307 tons of cannel coal, and 1,314,500 gallons of oil. The cannel coal and oil were used to enrich the gas, that is, increase either its heating value or its candlepower. It is usual for municipalities to establish certain requirements as regards the candlepower of the gas furnished by the gas companies, and in order to meet such requirements some producers of coal gas add cannel coal to the mixture in the retorts or vaporize oil and mix the oil gas with the coal gas. Cannel coal is rich in volatile hydrocarbons and in the past has been largely used for enriching illuminating gas, but petroleum and benzol have almost entirely replaced it for this purpose.

Both coke and anthracite are used as the source of carbon in the manufacture of water gas, and in 1915, 830,519 gross tons of anthracite and 1,318,226 net tons of coke were used for this purpose. The greater part of the coke so used was gas-house coke produced in coal gas plants operated in connection with the water-gas plants. Not uncommonly the gas supply for a city is a mixture of water gas and coal gas, the main supply being water gas and the coal-gas plant being only of such capacity as will supply sufficient coke for the manufacture of the water gas.

Water gas, which is a mixture of hydrogen and carbon monoxide, gives a colorless flame if burned in an open jet, and it is necessary to add gases with high candlepower in order to furnish a gas with sufficient illuminating power to meet the usual requirements.

Gas obtained by vaporizing petroleum or some of the petroleum products is used for this purpose, the resultant mixture being known as carbureted water gas. In 1915, 553,238,000 gallons of this "gas oil" was used in enriching water gas.

In the plants that manufacture straight oil gas 136,403,000 gallons of oil was used to produce 16,035,105,000 cubic feet of oil gas, or about 118 cubic feet of gas for each gallon of oil.

The fuels used in the manufacture of coal gas and water gas are shown in the following tables:

Fuels used in the manufacture of coal gas, 1915.

State.	Bituminous coal.	Cannel coal.	Oil.	Benzol.	Gas produced.
	Net tons.	*Net tons.*	*Gallons.*	*Gallons.*	*Thousand cubic feet.*
Alabama	74,551	.....	300	.....	920,282
California, New Mexico, and Wyoming	3,614	.....	.....	.....	40,966
Colorado	101,540	.....	.....	.....	1,241,028
Connecticut	152,828	97	374,971	1,700	1,544,694
Delaware, Florida, South Carolina, Vermont, and West Virginia	35,935	.....	10,143	.....	369,764
District of Columbia and Maryland	40,045	.....	.....	.....	383,678
Georgia	73,786	.....	100	.....	731,058
Idaho	6,930	.....	.....	.....	78,702
Illinois	208,671	.....	51,235	.....	2,363,304
Indiana	150,587	.....	.....	.....	1,459,512
Iowa	60,555	.....	.....	.....	601,700
Kansas, North Dakota, and South Dakota	20,475	.....	.....	.....	196,130
Kentucky	14,111	.....	.....	.....	136,780
Louisiana and Texas	11,982	.....	.....	.....	130,423
Maine	36,093	.....	.....	.....	360,736
Massachusetts	559,031	13	345,802	1,371	5,841,499

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Fuels used in the manufacture of coal gas, 1915—Continued.

State.	Bituminous coal.	Cannel coal.	Oil.	Benzol.	Gas produced
	Net tons.	*Net tons.*	*Gallons.*	*Gallons.*	*Thousand cubic feet.*
Michigan	629,492	.....	3,334	.....	6,371,003
Minnesota	84,164	.....	.....	.....	878,077
Mississippi	12,506	.....	.....	.....	126,108
Missouri	383,336	25	.....	a 100	3,438,166
Montana	8,951	.....	.....	.....	102,306
New Hampshire	14,914	.....	.....	.....	139,291
New Jersey	99,862	106	.....	.....	1,044,634
New York	828,933	41	353,428	8,909	8,347,116
North Carolina	33,173	.....	.....	.....	399,401
Ohio	95,572	.....	.....	.....	923,374
Oklahoma	6,048	.....	.....	.....	55,438
Oregon	3,387	.....	.....	.....	33,260
Pennsylvania	231,160	.....	6,266	.....	2,588,615
Rhode Island	112,802	.....	.....	.....	1,139,513
Tennessee	62,162	.....	114,494	41,725	651,249
Utah	35,002	.....	.....	.....	477,353
Virginia	90,801	.....	.....	.....	870,716
Washington	119,438	.....	600	.....	1,259,320
Wisconsin	237,268	25	.....	.....	2,393,209
	4,644,795	307	1,260,673	53,805	47,638,905

a Gasoline.

Fuels used in the manufacture of water gas, 1915.

State.	Anthracite.	Coke.	Oil.	Gas produced.
	Gross tons.	*Net tons.*	*Gallons.*	*Thousand cubic feet.*
Alabama	.....	3,644	594,608	174,828
Arkansas, Louisiana, and Oklahoma	.....	26,878	5,371,913	1,331,320
California, Oregon, and Utah	.....	18,642	4,413,712	731,078
Colorado	684	7,401	1,464,962	484,223
Connecticut	30,955	17,923	11,472,308	3,162,835
Delaware	9,111	167	1,921,820	571,554
District of Columbia and Maryland	78,730	10,772	22,087,021	5,873,366
Florida	2,326	8,042	1,911,404	539,428
Georgia	.....	12,219	3,023,750	850,951
Illinois	240	344,103	98,025,978	21,411,816
Indiana	.....	25,220	5,528,944	1,697,775
Iowa	773	49,304	10,532,611	2,864,696
Kansas	108	1,128	225,806	56,190
Kentucky and Mississippi	.....	2,664	458,504	120,417
Maine	1,481	2,457	806,525	231,543
Massachusetts	14,227	129,732	27,615,751	8,287,306
Michigan	161	31,589	6,091,913	1,692,762
Minnesota	.....	54,717	13,783,252	3,550,815
Missouri	.....	45,043	10,613,569	2,816,968
Montana	.....	1,339	253,029	70,542
Nebraska	.....	20,325	5,069,992	1,358,010
New Hampshire	3,643	5,449	1,805,937	523,284
New Jersey	111,214	73,991	43,869,583	11,970,196
New York	523,559	171,798	202,151,388	46,939,337
North Carolina	428	2,636	526,500	134,099
North Dakota	.....	513	77,446	25,406
Ohio	.....	6,717	1,316,661	314,167
Pennsylvania	44,269	149,976	51,816,505	12,648,668
Rhode Island	3,807	4,893	1,833,813	525,433
South Carolina	.....	6,498	1,477,531	396,195
South Dakota	300	4,498	867,816	224,880
Tennessee	.....	8,350	1,985,975	504,405
Texas	818	25,625	5,561,573	1,593,553
Vermont	3,213	152	657,161	181,260
Virginia	118	12,905	3,894,876	974,204
Washington	.....	14,538	2,887,055	662,133
West Virginia	.....	2,206	397,510	100,191
Wisconsin	354	14,172	2,844,561	741,804
	830,519	1,318,226	553,287,963	136,333,318

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NUMBER AND KINDS OF GAS PLANTS.

Several factors determine the selection of the process for the manufacture of gas. The old type of bench retorts for making coal gas requires a high grade of gas coal and produces a rich gas suitable for illumination, but the coke is soft and finds its best use as a heating fuel. This kind of plant is relatively expensive, and it is gradually being discarded in favor of water gas plants and of by-product coke ovens. The number of coal-gas plants of the old type in operation in 1915 was 396, compared with 424 in 1912 and 481 in 1908. The limited market for the coke usually places plants of this type at a disadvantage if they are located near a coal field, for the coke must then be sold in direct competition with cheap coal as domestic fuel. Furthermore, the coal-gas process is expensive to operate at a distance from the supply of gas coal because of transportation charges. The by-product coke oven which, in addition to its more economical operation, produces a coke that is suitable for blast furnace and foundry, is replacing the old-style bench retort as a source of gas for municipalities, and in 1915 of the 44 installations of ovens of the by-product type 13 sold all or part of their surplus gas for city supply.

Water gas is made by passing steam over incandescent carbon, either coke or anthracite, and has a high heating value but a low candlepower. To make it suitable for illumination, water gas is enriched with oil gas, the resulting combination of gases being known as carbureted water gas. The process is not so expensive to operate as the coal-gas benches, but the increasing cost of the large quantity of oil needed is now causing the operators much concern, and if the price of oil continues to advance some of the water gas companies will find the business unprofitable, particularly as the price at which their product is sold is often fixed by public utility commissions.

The number of coal-gas plants predominates in some States, as Michigan, Indiana, and Alabama; but, in general, the number of water-gas plants or of water-gas and coal-gas plants combined is greater in each State than the number of those making only coal gas.

Artificial-gas plants in the United States in 1915.[a]

State.	Coal gas.	Water gas.	Oil gas.	Coal gas and water gas.	Coal gas and oil gas.	Total.
Alabama	8			3		11
Arizona			7			7
Arkansas		1				1
California	1	2	62			65
Colorado	3	3		3		9
Connecticut	2	13	1	6	1	23
Delaware	1	5				6
District of Columbia				2		2
Florida	1	12		1		14
Georgia	8	4		2		14
Idaho	3					3
Illinois	24	28	1	12		65
Indiana	18	8		8		34
Iowa	7	45		5		57
Kansas	1	4		1		6
Kentucky	9	1				10
Louisiana	1	1	1			3
Maine	5	3		1		9
Maryland	5	7				12

[a] Exclusive of by-product coke ovens.

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Artificial-gas plants in the United States in 1915—Continued.

State.	Coal gas.	Water gas.	Oil gas.	Coal gas and water gas.	Coal gas and oil gas.	Total.
Massachusetts	13	16	1	19	.....	49
Michigan	38	6	.....	11	1	56
Minnesota	6	8	2	1	.....	17
Mississippi	6	2	.....	.....	.....	8
Missouri	8	13	1	1	.....	23
Montana	2	2	.....	1	.....	5
Nebraska	.....	18	.....	.....	.....	18
Nevada	.....	.....	3	.....	.....	3
New Hampshire	2	6	1	2	.....	11
New Jersey	5	24	.....	2	.....	31
New Mexico	1	.....	1	.....	.....	2
New York	19	48	.....	15	.....	82
North Carolina	8	10	.....	1	.....	19
North Dakota	2	3	.....	.....	.....	5
Ohio	8	5	1	2	.....	16
Oklahoma	2	1	.....	1	.....	4
Oregon	3	1	6	.....	.....	10
Pennsylvania	11	68	.....	2	.....	81
Rhode Island	1	2	.....	2	.....	5
South Carolina	1	7	.....	.....	.....	8
South Dakota	1	7	.....	1	.....	9
Tennessee	4	1	.....	2	.....	7
Texas	1	16	2	1	.....	20
Utah	2	.....	.....	1	.....	3
Vermont	2	7	.....	.....	.....	9
Virginia	5	4	.....	6	.....	15
Washington	6	2	.....	3	.....	11
West Virginia	2	3	.....	.....	.....	5
Wisconsin	14	13	1	5	.....	33
Wyoming	1	.....	.....	.....	.....	1
	271	430	91	123	2	917

Coal-gas plants (only)	271
Coal-gas plants operated with water-gas plants	123
Coal-gas plants operated with oil-gas plants	2
Total coal-gas plants	396
Water-gas plants	430
Water-gas plants operated with coal-gas plants	123
Total water-gas plants	553
Oil-gas plants	91
Oil-gas plants operated with coal-gas plants	2
Total oil-gas plants	93

BY-PRODUCTS.

The value of artificial gas and by-products, those obtained in the manufacture of coke included, was $255,000,000 in 1915, compared with $211,558,147 in 1912.

The value of by-products alone, coke being considered as the principal product of the by-product plants and gas as the chief product of the other plants and both those items being excluded, was $41,327,392 in 1915. The ammonia recovered in the distillation of coal in both old and new types of ovens was valued at more than $11,100,000, the tar obtained sold for $6,246,000, and other products, such as benzol and other oils, coke breeze, and retort carbon had an aggregate value of $8,000,000. The by-products from the manufacture of coal gas (exclusive of coke-oven products) and oil gas and water gas had a value of more than $11,000,000.

The values of these products are summarized in the following table and the quantities and values are shown in succeeding pages.

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Value of artificial gas and by-products, 1915.

	Gas.	Coke.	Tar.	Ammonia.	Other products.	Total.
By-product coke ovens	$8,624,809	$48,558,325	$3,568,384	$9,967,475	$7,763,821	$78,382,904
Coal-gas retorts	40,257,108	7,198,377	1,555,363	1,329,651	53,488	50,393,987
Water-gas plants	112,281,956	.....	1,118,656	.....	68,351	113,468,963
Oil-gas plants	12,668,169	.....	4,268	.....	174,659	12,847,096
	173,832,132	55,756,702	6,246,671	11,197,126	8,060,319	255,092,950

Coke, tar, and ammonia produced and marketed at coal-gas works and by-product coke ovens in the United States, 1902–1915.

	1902		1903	
	Quantity.	Value.	Quantity.	Value.
Coal used.....net tons..	5,015,511	.....	5,843,538	.....
Coke.....do....	3,377,763	$11,267,608	3,941,282	$13,634,095
Tar.....gallons..	53,171,733	1,873,966	62,964,393	2,199,989
Ammonia (reduced to NH_3).....pounds..	14,683,374	1,065,300	17,643,507	1,291,732
Ammonium sulphate.....do....	11,276,502	319,685	12,400,032	389,028

	1904		1905	
	Quantity.	Value.	Quantity.	Value.
Coal used.....net tons..	7,056,157	.....	8,187,812	.....
Coke.....do....	4,716,049	$14,663,126	5,751,378	$18,844,866
Tar.....gallons..	69,498,085	2,114,421	80,022,043	2,176,944
Ammonia (reduced to NH_3).....pounds..	19,750,032	1,487,196	22,455,857	1,728,254
Ammonium sulphate.....do....	28,225,210	771,995	38,663,682	997,452

	1907		1908	
	Quantity.	Value.	Quantity.	Value.
Coal used.....net tons..	11,490,661	.....	9,252,978	.....
Coke.....do....	8,093,144	$30,332,644	6,253,125	$21,507,045
Tar.....gallons..	103,577,760	2,651,527	101,261,329	2,537,118
Ammonia (reduced to NH_3).....pounds..	37,560,858	2,601,057	30,615,835	2,065,169
Ammonium sulphate.....do....	48,882,237	1,525,472	44,093,437	1,322,807

	1912		1915	
	Quantity.	Value.	Quantity.	Value.
Coal used.....net tons..	18,724,603	.....	24,199,177	.....
Coke.....do....	12,490,757	$48,380,009	15,735,447	$55,756,702
Tar.....gallons..	134,796,438	3,802,047	186,277,793	5,123,747
Ammonia (reduced to NH_3).....pounds..	51,527,074	4,776,386	.....	.....
Ammonium sulphate or its equivalent...do....	99,070,777	3,740,075	498,098,035	11,197,126
Ammoniacal liquor.....gallons..	35,242,549	1,002,807	.....	.....

COKE.

The quantity of coke obtained in the manufacture of coal gas in the old style of retorts in 1915 was 2,941,000 tons, of which 1,663,000 tons was sold. The remainder, 1,278,000 tons, was used either as fuel for heating the retorts or in the production of water gas at plants

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where both kinds of gas are manufactured. This coke was obtained from 4,665,000 tons of coal and represents a yield of coke from coal of 63 per cent. Compared with the total production of coke in the United States, the marketed production of gas-house coke is small. This kind of coke is soft and is suitable only for fuel, for which purpose it finds a ready market, mainly for domestic use. The statistics of production and sales of gas-house coke, by States, are given in the following table. The total output of by-product coke is also shown, the statistics of which, by States, will be found in the current report on coke in this series.

Coke produced and sold from coal-gas plants in 1915.

State.	Quantity.		Value.	Price per ton.
	Produced (net tons).	Sold (net tons).		
Alabama	45,315	29,552	$96,806	$3.28
California, Montana, New Mexico, and Wyoming	5,630	4,377	32,998	7.54
Colorado	63,618	53,659	145,900	2.72
Connecticut	90,327	36,552	142,927	3.91
Delaware, Florida, South Carolina, and West Virginia	19,414	9,421	37,678	4.00
District of Columbia and Maryland	23,170	11,121	50,338	4.53
Georgia	45,880	24,007	91,998	3.83
Idaho	4,226	3,179	18,320	5.92
Illinois	155,226	115,326	438,389	3.80
Indiana	97,386	47,933	179,624	3.75
Iowa	34,525	23,426	128,448	5.48
Kansas, North Dakota, and South Dakota	11,519	7,609	47,927	6.30
Kentucky	6,944	2,446	6,437	2.63
Louisiana, Oklahoma, and Texas	11,307	5,834	29,510	5.06
Maine	16,771	10,894	62,972	5.78
Massachusetts	334,686	175,226	857,726	4.89
Michigan	416,901	286,505	1,319,637	4.61
Minnesota	52,835	8,004	47,660	5.95
Mississippi	6,117	4,615	15,615	3.38
Missouri	243,617	84,932	325,325	3.83
New Hampshire	8,764	5,977	30,331	5.07
New Jersey	62,877	10,728	42,147	3.93
New York	543,406	283,284	1,077,573	3.80
North Carolina	52,005	11,981	52,290	4.36
Ohio	60,104	48,442	199,222	4.11
Oregon	1,999	1,250	6,115	4.89
Pennsylvania	150,464	125,283	653,223	5.21
Rhode Island and Vermont	22,111	8,111	34,273	4.23
Tennessee	39,153	26,742	73,500	2.75
Utah	21,651	11,580	55,074	4.76
Virginia	51,432	23,012	97,995	4.26
Washington	81,045	36,746	191,345	5.21
Wisconsin	160,501	124,798	608,554	4.88
	2,940,926	1,662,552	7,198,377	4.33
By-product oven coke	14,072,895	14,072,895	48,558,325	3.45
Grand total	17,013,821	15,735,447	55,756,702	3.54

TAR.

Tar is obtained in the manufacture of coal gas, oil gas, and water gas, the tar from water gas being derived mainly from the oil that is used for enriching the water gas. The market for tar is limited, and many of the gas plants use a large part of the tar produced for fuel. The total production of tar in 1915 was 276,745,885 gallons, of which 39,021,748 gallons, or 14 per cent, was used for fuel, and 237,724,137 gallons, or 86 per cent, was sold.

The marketed production of coal tar obtained from both the old-style bench retorts and from by-product coke ovens was 186,278,000 gallons, valued at $5,124,000, in 1915, compared with 134,796,000

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gallons, valued at $3,802,000, in 1912. The average price of all coal tar in 1915 was 2.8 cents a gallon, the same as in 1912. The average price of tar from by-product ovens was 2.6 cents a gallon in 1915; it was 2.5 cents a gallon in 1912.

The statistics of marketed production of coal tar are shown in the following table by groups of States, according to the system adopted by the United States Census, as in many of the States the number of plants reporting sales of tar was less than three, and hence to publish totals for those States would disclose individual reports.

Tar produced and sold from coal-gas plants and by-product coke ovens, in 1915.

State.	Number of plants.	Tar sold (gallons).	Value of sales.	Average price.
New England division:				
Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut	49	17,237,387	$505,331	$0.029
Middle Atlantic division:				
New York, New Jersey, Pennsylvania	58	51,948,603	1,319,333	.025
East north-central division:				
Ohio, Indiana, Illinois, Michigan, Wisconsin	146	71,154,896	1,962,787	.028
West north-central division:				
Minnesota, Iowa, Missouri, North Dakota, South Dakota, Kansas	32	7,204,534	250,280	.035
South Atlantic division:				
Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida	40	7,657,357	257,275	.034
East south-central division:				
Kentucky, Tennessee, Alabama, Mississippi	34	27,306,884	647,948	.024
West south-central division:				
Louisiana, Oklahoma, Texas	6	200,008	10,194	.051
Mountain division:				
Montana, Idaho, Wyoming, Colorado, New Mexico, Utah, Nevada	15	1,984,042	97,113	.049
Pacific division:				
Washington, Oregon	13	1,584,082	73,486	.046
	393	186,277,793	5,123,747	.028

Tar is also obtained in the manufacture of oil gas and water gas, and the quantity produced in 1915 from those sources was 51,446,344 gallons, valued at $1,122,924, an average of 2.2 cents a gallon, compared with an average of 2.8 cents a gallon for coal tar in 1915 and of 2.8 cents a gallon for oil-gas and water-gas tar in 1912.

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Tar produced and sold from water-gas and oil-gas plants, 1915.

State.	Number plants.	Tar sold (gallons).	Value of sales.	Average price.
New England division:				
Maine				
New Hampshire				
Vermont	27	2,556,357	$74,021	$0.029
Massachusetts				
Rhode Island				
Connecticut				
Middle Atlantic division:				
New York				
New Jersey	56	20,938,306	519,305	.025
Pennsylvania				
East north-central division:				
Ohio				
Indiana				
Illinois	31	20,216,800	275,209	.014
Michigan				
Wisconsin				
West north-central division:				
Minnesota				
Iowa				
Missouri				
North Dakota	36	3,899,368	116,628	.030
South Dakota				
Nebraska				
Kansas				
South Atlantic division and Alabama:				
Delaware				
Maryland				
District of Columbia				
Virginia				
North Carolina	25	2,800,271	95,017	.034
South Carolina				
Georgia				
Florida				
Alabama				
West south-central division:				
Arkansas				
Oklahoma	10	229,726	5,993	.026
Texas				
Mountain division:				
Montana	3	106,476	2,911	.027
Colorado				
Pacific division:				
Washington				
Oregon	8	699,040	33,840	.048
California				
	196	51,446,344	1,122,924	.022

AMMONIA.

Many of the establishments producing gas and coke from coal report the recovery of ammonia, the returns being either for ammoniacal liquor, NH_3, or ammonium sulphate. In making the reports on the quantity of ammonia liquor produced somewhat different methods are employed. Some companies report the production in liquid ounces, sales being at a certain price per 100 liquid ounces of a specific strength; others report the production in gallons, sales being at a certain price per pound or by the ammonia (NH_3) contained; others report the production in gallons of ammonia liquor at so much per gallon, according to the strength of the liquor. Then again, the strength of the liquor is reported by some producers in ounces, and by others in the percentage of anhydrous ammonia (NH_3).

In preparing the statistics of production of ammonia for the present report the production of liquor has been reduced to the equivalent in ammonium sulphate.

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The total production of ammonium sulphate or its equivalent from coal-gas plants in 1915 was 52,311 tons of 2,000 pounds, of which 51,921 tons was sold at a value at the works of $1,329,651. The marketed production of ammonium sulphate from by-product coke-oven plants was 197,128 tons, valued at $9,867,475, and the total for the United States was 249,049 tons, valued at $11,197,126.

The production and sales of ammonium sulphate by States in 1915, and the total production in the United States in 1907, 1908, 1912, and 1915, are given in the following tables:

Ammonium sulphate or its equivalent produced and sold in 1915.

State.	Number of plants.	Quantity.		Value.
		Produced (pounds).	Sold (pounds).	
New England division:				
Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut	27	13,817,870	14,758,062	$230,752
Middle Atlantic division:				
New York, New Jersey, Pennsylvania	19	54,259,514	53,265,780	391,719
East north-central division:				
Ohio, Indiana, Illinois, Michigan, Wisconsin	44	19,155,650	18,590,310	378,479
West north-central division:				
Minnesota, Iowa, Missouri, North Dakota	7	9,654,008	9,543,392	205,154
South Atlantic division:				
District of Columbia, Virginia, North Carolina, Georgia, Florida	11	2,278,188	2,303,811	43,777
East south-central division:				
Tennessee, Alabama, Mississippi	7	1,789,124	1,762,736	26,060
Mountain division:				
Idaho, Colorado, Utah	4	1,758,328	1,763,668	29,256
Pacific division: Washington	5	1,909,952	1,854,276	24,454
	124	104,622,634	103,842,035	1,329,651
By-product coke ovens			394,256,000	9,867,475
Grand total			498,098,035	11,197,126

Ammonia produced at gas and by-product coke works of the United States in 1907, 1908, 1912, and 1915.

	1907	1908	1912	1915
NH_3, or its equivalent, produced and sold pounds	37,560,858	30,615,835	51,527,074	53,347,462
Ammoniacal liquor gallons			35,242,549	12,280,670
Ammonia produced and sold as sulphate pounds	48,882,237	44,093,437	99,070,777	206,368,410
Value of NH_3 or its equivalent	$2,601,057	$2,065,169	$4,776,386	$4,068,054
Value of ammoniacal liquor			1,002,807	1,319,257
Value of ammonium sulphate	1,525,472	1,322,807	3,740,075	5,809,815
Total value	4,126,529	3,387,976	9,519,268	11,197,126

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OTHER BY-PRODUCTS.

In addition to the coke, gas, tar, and ammonia obtained in the manufacture of artificial gas, other products, as oils and retort carbon, are saved. Except the benzol and other light oils recovered from coke-oven gas, these are not of great importance. The details are given in the following table and a fuller discussion of these products from coke-oven gas will be found in the current report of this series on coke.

Miscellaneous by-products obtained in the manufacture of artificial gas, 1915.

Product.		Quantity obtained and sold.	Value.
Coal gas (bench retorts).			
Benzol	gallons	15,072	$6,825
Holder oils	do	244,022	18,818
Drip oils	do	267,557	14,361
Creosote	do	60,331	9,557
Naphthalene	pounds	223,925	3,565
Retort carbon	net tons	120	1,362
		.....	53,488
Coal gas (by-product coke ovens).			
Benzol products:			
Crude light oils	gallons	13,082,678	4,304,281
Secondary light oils	do	182,099	28,731
Benzol	do	2,516,483	1,428,323
Toluol	do	623,506	1,529,803
Solvent naphtha	do	196,151	46,233
Naphthalene	pounds	465,865	46,950
Breeze, retort carbon, domestic coke and coke dust, and aniline oil		.....	379,491
		.....	7,763,821
Water-gas plants.			
Drip oil	gallons	154,569	10,133
Holder oil	do	635,307	49,707
Retort carbon	net tons	741	8,511
		.....	68,351
Oil-gas plants.			
Lamp black, Retort carbon, Petroleum coke	net tons	26,459	174,659
Total		.....	174,659
		.....	8,060,319

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